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CHILD HEALTH AND DEVELOPMENT

BY

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PREFACE

At a time of rapid social change and reconstruction, when neither the birth-rate nor the general standard of child care gives cause for complacency, it is felt that a book dealing specifically with the development of the normal child and the services existing for his welfare may be found useful. The importance during medical training of the study of child health, as opposed to a too-exclusive preoccupation with disease in childhood, has recently been stressed in the Report of the Inter-departmental Committee on Medical Schools (1944). It is probable that a similar emphasis will be placed on child health in the training of nurses, health visitors and social workers intending to devote themselves to the care of children.

For convenience, this book has been divided into two parts. The first, which assumes a basic medical knowledge, deals with the physical, emotional and intellectual development of the normal child. In the second part are considered various social services and conditions directly related to child health. No attempt has been made to summarize the legislation relating to child health, but reference is given to the more important Acts in so far as these are already implemented. (It should be explained that the dates given for Acts relate to England; corresponding legislation for Scotland has in most instances been enacted within one or two years of the passing of the original Act. Where the Ministries of Health and Education are referred to, the Scottish authority is the corresponding Department, Cabinet representation being vested in the Minister of State for Scotland.) That existing legislation is in many ways inadequate, and in some ways even conflicting, is shown by the Report of the Care of Children Committee (1946, H.M.S.O.), which has appeared whilst this book was in the press; the report further proves that the objects of legislation for the care and protection of children can only be achieved if the provisions are carried out with intelligence and understanding.

In addition to the authors of signed contributions, I wish to thank the officials of the various voluntary and other organizations who have kindly supplied material, and the friends and colleagues (including Professor M. A. Rushton, Professor W. R. Spurrell, Mr. G. F. Gibberd and Drs. P. M. Bishop, J. S. Bradshaw and M. W. Goldblatt) who have most helpfully criticized parts of the manuscript. Grateful acknowledgement is also made to the authors, editors and publishers named in the text who have given permission for the reproduction of illustrations, and to Miss S. Treadgold for a number of the photographs and line-drawings.

In conclusion, I would express my deep indebtedness to the late Dr. R. D. Gillespie, with whose help and advice the project and scope of this book were originally planned.

R. W. B. E.

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INTRODUCTION

GENERAL CONSIDERATIONS

For the child to have either health or development, he must first be conceived and subsequently born. To go back still further, the child will be influenced by the genetic constitution of his parents, whilst the mother's health in early childhood (*e.g.*, the presence or absence of rachitic deformity of the pelvis) may profoundly affect the infant's extra-uterine life. Even before the major hazard of birth has been negotiated, social and economic factors can prejudice the child's chances of normal physical development, whilst after birth the emotional security of his home life will be at least as important as material well-being in the development of a whole and balanced individual.

It follows that in any attempt to study the health and development of the child, he must be viewed against his hereditary, social, and economic background. It must be remembered that his intra-uterine life lays the foundation for his postnatal health, and that birth, though an unavoidable necessity, is only one milestone on his journey from the uterus to the grave. His place in the family, the age of his parents at his birth, and their marital relationship are all factors which must be considered in the evaluation of the individual child.

Conception. It is an elementary biological principle that mating and procreation occur when maturity is reached, and that the latter continues during the child-bearing period. This allows for a considerable margin of safety, covering the wastage due to infantile mortality and the hazards of childhood and later life. Civilization, and particularly industrialization, have so modified this course of events that we are faced with a birth rate which, in spite of a steady reduction in infantile mortality during the present century, is now giving rise to considerable alarm. The alarm is probably the more vocal since the reduction in the birth rate is not evenly distributed over all social grades, but even if this factor is discounted it is generally conceded that concern over the situation as a whole is justified.

Although a very large number of social and economic factors are involved, which are at present under review by the Royal Commission on Population, two main causes which have a direct bearing on the production of children may be mentioned :

(1) Infertility of the Parents. This may be absolute or relative in either partner. Relative infertility occurs in both sexes during early adolescence and again in later life before it becomes absolute. It may also be the result of specific disease or general debility, whilst a particular union may prove infertile although no cause is found in either partner. In the normal individual, the chances of conception occurring are greatest within forty-eight hours of ovulation. This normally occurs thirteen to fifteen days before the commencement of the next menstrual period or, within a twenty-eight day cycle, on approximately the fourteenth day after the beginning of the previous period. Various environmental and other factors, *e.g.*, lactation, may result in one or more anovular cycles, during which, despite menstruation, conception cannot occur.

Since there is a more or less constant decline in fertility in later life, any social or economic factors tending to delay marriage until the fourth decade will shorten the child-bearing period and diminish the probability of pregnancy occurring.

(2) **Intentional Deferment of First Pregnancy or Limitation of Family.** The intentional deferment of a first pregnancy until some years after marriage or the artificial limitation of family to one or two children is often undertaken for what are regarded as reasons of economic necessity, or merely for convenience. Whilst there are strong arguments in favour of carefully-considered ‘ spacing ’ of children, and medical reasons which may make any pregnancy undesirable, there is great danger that long-continued contraception during the early years of marriage may result in a childless or single-child marriage, a state of affairs not originally intended and which may be ultimately deplored. It is much commoner to find this occurring amongst the intellectual and professional groups than in the manual labour class. It is by no means a simple issue, however, and there is little question that the substantial improvement in the general level of child health that has occurred during the present century is to some extent related to the frequency of smaller families. Since this obviously does not apply to childless marriages (which were estimated by Giles (1919) as representing about 10 per cent. among the working population and 16 per cent. among the leisured classes), factors tending to result in childless marriage must be seriously considered in a system of social planning. In some cases childbearing is avoided from a genuine economic insecurity, or a fear of lowering standards that are socially desirable ; in such cases a more liberal maternity benefit, an extension of family allowances to first children, and a system of priority in domestic help, are possible measures for the encouragement of fertile marriage.

Antenatal Development. From Chapters I and II it will be seen that antenatal care, including supervision of maternal diet, is closely related to the successful development of the fœtus and completion of the full term of pregnancy. Whilst many of the old wives' tales with regard to the effect of environment on the fœtus have been discredited, other factors causing congenital abnormality (such as rubella in early pregnancy and the rhesus factor) have recently been brought to light; it is not too much to hope that with a clearer knowledge of the cause, an increasing number of fœtal calamities which have previously been regarded as unavoidable, may be averted or controlled. The inherent difficulties of applying genetic principles to human material are discussed in Chapter XII, but here again it is probable that an increasing number of hereditary disabilities may be forecast, and more helpful advice given to those contemplating marriage or fearing the appearance of a particular disability in a second child. To take a concrete example, Fogh-Andersen (1942) has made an exhaustive analysis of the cases of hare-lip (plus cleft palate) and of isolated cleft-palate occurring in Denmark, and reached the conclusion that whilst most cases of hare-lip (plus cleft palate) must be regarded as hereditary, the cases of isolated cleft palate showed a considerable proportion of non-hereditary examples. In the case of hare-lip (plus cleft palate), it could be said that the offspring of parents showing the deformity were rarely affected, even when there was a family history of the condition, the probable incidence being about 2 per cent. Advice was, however, given against marriage with another affected individual, this possibility being not altogether remote owing to frequent meetings at speech-training classes. (The same might apply to diabetics brought up in special schools). It was, however, considered that there was not the same reason for dissuading a patient with hare-lip (plus cleft palate) from mating with an individual suffering from isolated cleft palate. Furthermore, if a patient with hare-lip (plus cleft palate) had had one child who was similarly affected, it was considered that the chances of further children being affected were in the region of 10 to 15 per cent. These chances could be explained to the parents and qualified advice against future pregnancies given.

Postnatal Development. The long period of apprenticeship which man serves before reaching full intellectual and emotional development is associated with a corresponding period of gradually diminishing physical immaturity. In early infancy he is exceptionally vulnerable, not only to trauma but to extremes of temperature (owing to the immaturity of his heat-regulating mechanism), changes in diet, and infection. His central nervous system is poorly myelinated, his digestive tract capable of dealing with little more than a milk diet, and his blood-forming organs readily disorganized. It is well known that during infancy a large variety of noxious stimuli may initiate convulsions, diarrhœa and vomiting, or anæmia. The lobulated kidney of the newborn infant is a relatively inefficient organ (McCance and Young, 1941), and the functional capacity of the adult kidney is only gradually attained (see Fig. 1). Dehydration occurs readily and may have disastrous consequences, and the acid-base balance of the infant is easily upset.

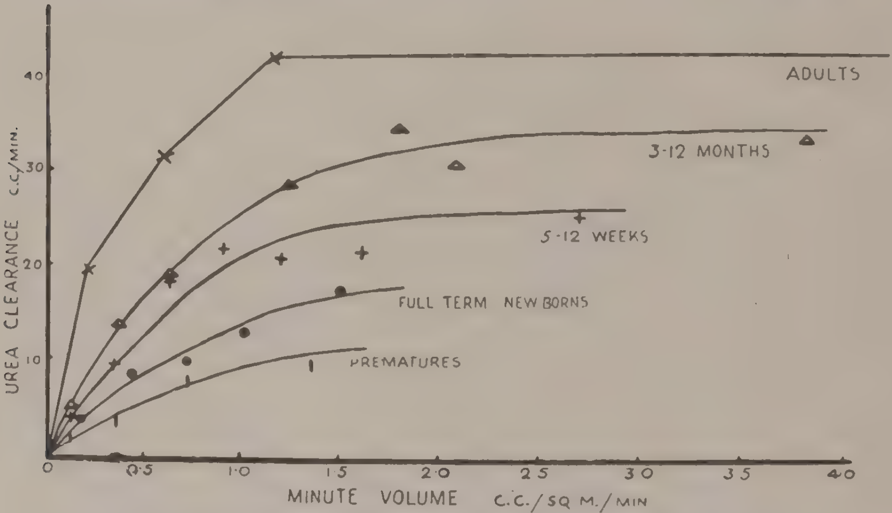
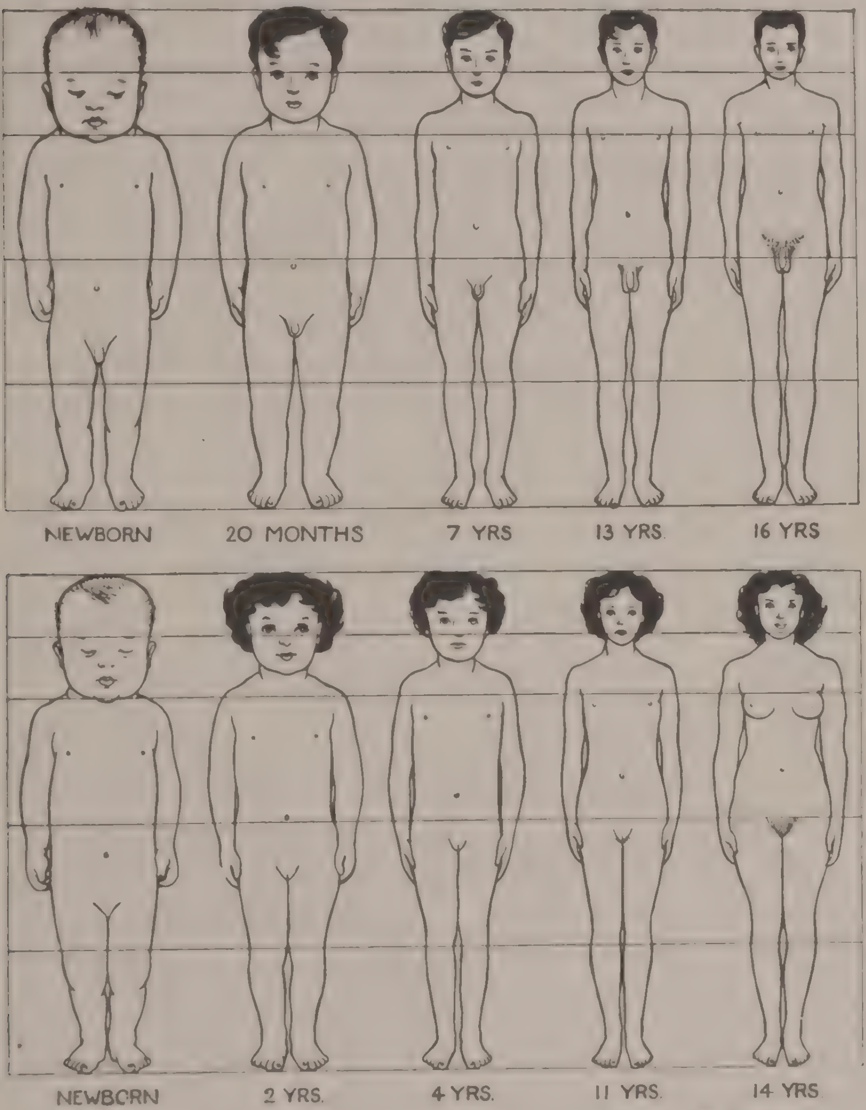


FIG. 1. Comparison of the average urea clearances of adults and of infants at four different ages. (Young, W. F., and McCance, R. F., *Arch. Dis. Childh.*, 1942, 17, 65.)

Perhaps the most striking differences between the infant and adult, however, are at first the infant's requirement for sleep and later his capacity for play. Whereas the adult is satisfied with seven or eight hours' sleep out of the twenty-four, the newborn infant will sleep for twenty-one or twenty-two hours, waking only for feeding and washing. With increasing age, the sleep requirements diminish gradually but remain higher than those of the adult until maturity is reached. Lack of sleep due to overcrowding of children of different ages, the abuse of the wireless, working hours of the parents and other disturbances, is a frequent cause of chronic fatigue and sub-normal health in childhood. The afternoon sleep is often abandoned too soon, and the younger child's night sleep sacrificed to the convenience of older members of the family. This high sleep-requirement in infancy and childhood is associated with a high basal metabolic rate, which falls steadily (save for a temporary acceleration at puberty) from infancy to adult life.


NEWBORN
20 MONTHS
7 YRS
13 YRS.
16 YRS
NEWBORN
2 YRS.
4 YRS.
11 YRS.
14 YRS

Figs. 2 and 3. Diagrams showing relative proportions of the body from birth to puberty (constructed from figs. 38 and 39).

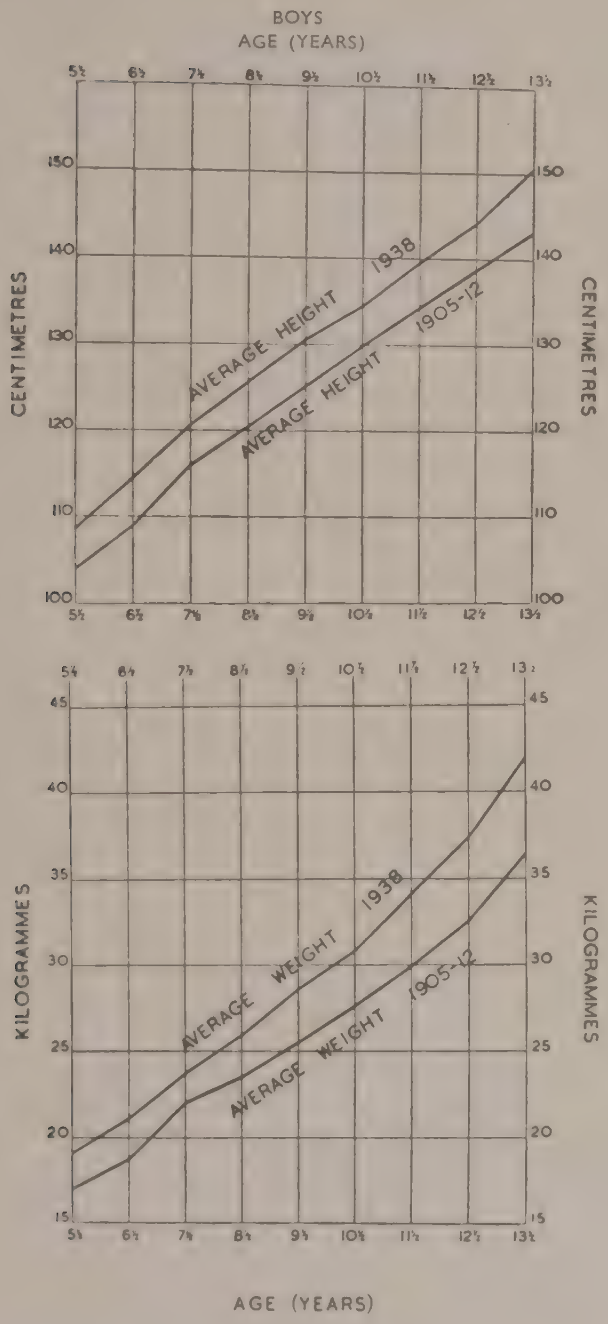
The importance and significance of play in childhood have only been widely recognized comparatively recently. Amongst young animals, play represents an essential part of the training for future life, and it is generally true that the more intelligent the species, the longer and more elaborate is the period of play-apprenticeship. Recognition of the same principle as applying to children has done much to revolutionize the system of education during the nursery years, whilst play-therapy has become firmly established as a method of dealing with many of the emotional and other difficulties of childhood.

Physical growth, as emphasized in Chapter VII, is not simply a matter of increase in height and weight. The changes in relative proportions which occur between birth and puberty are illustrated in figs. 2 and 3.

These changes will subsequently be considered in detail, but it should be realized from the outset that neither the infant nor the child is a 'man in miniature.' Although growth in height is accompanied by recurrent periods of 'filling out,' it will be seen that there is a gradual increase in the length of the limbs as compared with the total height, and a relative diminution of the size of the head. The infant is large-headed, short-limbed, squat and rounded, whilst the early adolescent is a slender long-limbed, gazelle-like creature who subsequently is transmuted into the only too familiar sheep-like adult.

Average figures for height and weight of children of different ages have a considerable value in comparing large groups of children; but in assessing the individual child, the distribution curves for each age group should be known and the standard deviation considered; it must also be borne in mind that there will be variations in body-build and maturity of ossification which may be genetically determined, and which are not adequately expressed in the over-simple 'weight-for-height' standards which are sometimes used. Of the many anthropometric formulæ which have been proposed for the assessment of malnutrition in individual children, it is doubtful if any are really less misleading than experienced clinical judgment when applied to a single examination. The height and weight curves of individual children constructed over a long period may, however, be most valuable in assessing the state of nutrition and development at any given time.

There is good evidence that the mean values both for height and weight of children in different age groups may show substantial changes within a comparatively short period, depending on such factors as economic depression and changes in diet. A good example of this is given by the mean heights and weights of children in the London County Council area in 1938 compared with the earlier standards prepared in 1905–12 (Menzies, 1940).



Figs. 4 and 5. Mean height and weight of elementary school children (boys) for the years 1905–12 and 1938. (From 'Report on the Average Heights and Weights of Elementary School Children in the County of London,' by Sir Frederick Menzies, 1940. L.C.C.)

It will be seen that the mean heights and weights for boys had both increased considerably in every age group; the figures for girls showed essentially similar changes. The 1938 figures were also analysed in relation to boroughs, and it was found that the means for children at school in the better circumstanced boroughs were generally above, and those in the poorer boroughs generally below, the average figures representative of the country as a whole. Daley (1944) carried out an investigation of the 1942 and 1943 figures for London elementary school children as part

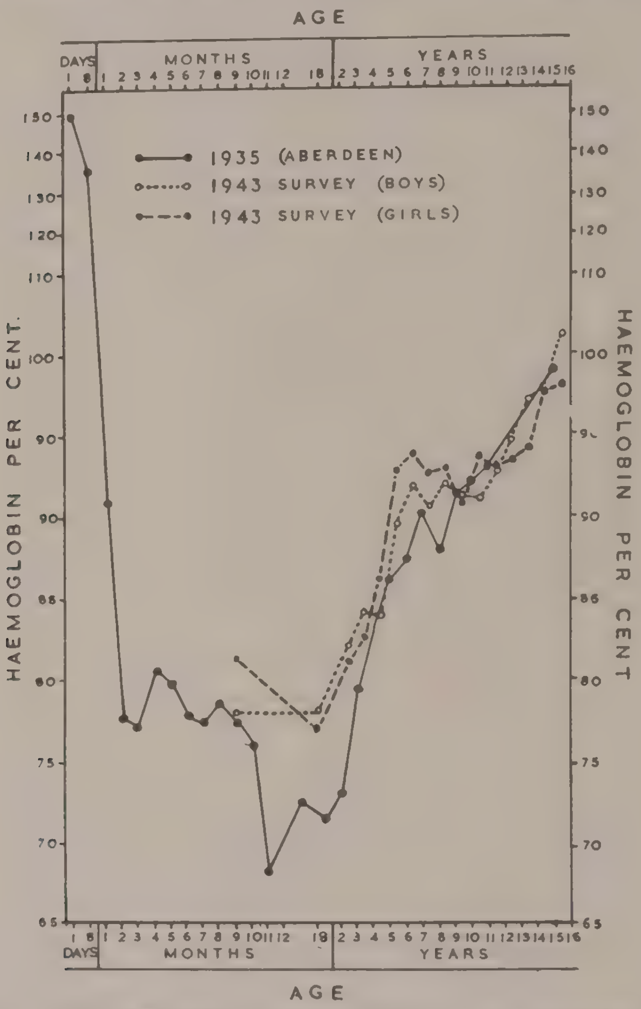


FIG. 6. Mean hæmoglobin levels according to age, Aberdeen 1935, compared with 1943 survey (sex and age). (After Medical Research Council, Special Report Series No. 252, 1945. By permission of the Controller, H.M.S.O.)

of the measures for the supervision of nutritional status during the war, and found that at most ages the children in the south-western division had increased in height and weight since 1942 and had exceeded the corresponding figures for 1938, whilst the children in the north-eastern division had increased in height and weight since 1942 but had not quite attained the 1938 standards.

Hæmoglobin Level. In addition to clinical, anthropometric, and biochemical tests of nutritional status, some indication of the physical well-being of a community can be reached by surveys in which the average heamoglobin level is estimated. Since many of these surveys have been carried out on children living in towns and institutions, the available figures must be interpreted with this in mind. We can speak of the mean hæmoglobin level at different ages in a particular community; the respective levels to which these means may be raised by the addition of iron to the diet, by improved nutrition, or by other methods; or establish ‘ normal ’ or ‘ ideal ’ standards by estimations made on children considered to be living in ideal conditions and in perfect health. In the last event, it must be remembered that the hæmoglobin level is likely to be substantially higher in those living in high mountains than in those at sea-level.

Fig. 6 shows the hæmoglobin levels at different ages of infancy and childhood, obtained in two recent surveys. The Aberdeen survey (Davidson *et al.*, 1935) was carried out on children in poor circumstances, whilst the 1943 survey (Med. Res. Council, 1945) included children of all social grades.

It is unfortunate that there are no pre-war British figures available for the hæmoglobin level of infants whose parents were in easy circumstances. Mackay (1931, 1933) gave a suggested ‘ normal ’ value of 86 per cent. for infants aged five to fourteen months, based on the level to which the percentage hæmoglobin could be raised by the addition of iron to the diet in infants studied in one of the poorer districts in London. It will be seen that the Aberdeen percentages for this age group were substantially lower. Mackay's ‘ average ’ figures, *i.e.*, average values before treatment, were also 10 to 16 per cent. lower than the ‘ normal ’ artificially-fed infants; the differences were slightly less in the case of breast-fed infants. In a more recent study made on infants and young children attending war-time day nurseries in North London, Mackay *et al.* (1946) showed that the administration of ferrous iron led to a small but significant rise in mean hæmoglobin level, whilst a 6 per cent. rise was associated with a 26 per cent. reduction in absentee rate as compared with a control group in the same nursery. The present evidence suggests that a minor degree of iron-deficiency anæmia is still relatively common amongst infants and young children in large cities in Britain. It is probable that this anæmia is associated with a lowered resistance to infection, whilst recurrent infection will in turn tend to perpetuate the anæmia.

Social Responsibility for Child Health and Welfare

That the community as a whole should accept any responsibility for children is a conception of comparatively recent growth. Practically every measure for protection of children by the State has been bitterly opposed on the grounds that it would either interfere with individual liberty or would remove responsibility from the parents and destroy the principles of family life. It has also been rightly pointed out that when responsibility is accepted for children by the State, they must be protected against exploitation in the support of any particular ideology or economic system. This widespread distrust of compulsion has usually meant that legislation has only been enacted when the case for it has become overwhelming, and that a vast amount of social work for children has been carried out by voluntary and independent bodies such as the National Society for the Prevention of Cruelty to Children, Dr. Barnardo's Homes, and the voluntary hospitals. Many organizations such as infant welfare centres have at first largely been started by voluntary effort, subsequently being supported and finally taken over by Local Authorities.

Amongst European countries during the last century, England was peculiar in many respects owing to the magnitude and rapidity of the industrial revolution. An increase of population from nine millions in 1801 (when the first census was taken) to 32·5 millions in 1901 was accompanied by an overwhelming shift from rural to urban environment. The mushroom growth of slums and the appearance of a smoke pall over all the larger cities resulted in rickets becoming 'the English disease,' whilst the demands for cheap labour resulted in children being exploited in industry to a very considerable extent. In looking back over the misery and destitution which prevailed during and after the 'hungry forties,' and the fact that most measures for the improvement of social and working conditions were strongly opposed in Parliament, it must be remembered that comparatively few legislators either knew or cared about the living conditions of the industrial worker in an era that had brought general prosperity to their own privileged class. Lord Shaftesbury was an outstanding exception, and it would be difficult to overestimate the importance of his championship of destitute and working children both in Parliament and as President of 'The Ragged School Union'; he lived to see many of the reforms he initiated brought to fruition. Another great reformer, whose novels served to bring home to a very wide public the iniquities of the existing system, was Charles Dickens. Oliver Twist, the poor-law child, and Sarah Gamp, the contemporary midwife, became national figures who did much to unsettle Victorian complacency.

During the present century, three elementary conceptions have gradually taken root. It is now generally conceded that a high infantile mortality is wasteful, that a falling birth rate may prove disastrous, and that the child as an individual has certain fundamental rights. This last is more revolutionary than it may at first sight seem, since it cuts across the principle of the parent or 'guardian' being the sole arbiter of fate. It is useful in this connection to recall the Charter which was drawn up after the World War of 1914–18 by the founder of the Save the Children Fund, and endorsed by many governments, and to consider how far it has been fulfilled in the intervening years: 'By the present Declararation of the Rights of the Child, commonly known as the Declaration of Geneva, men and women of all nations, recognizing that Mankind owes to the Child the best that it has to give, declare and accept as their duty that, beyond and above all considerations of race, nationality, or creed:

I. The child must be given the means requisite for its normal development, both materially and spiritually.

II. The child that is hungry must be fed; the child that is sick must be nursed; the child that is backward must be helped; the delinquent child must be reclaimed; and the orphan and waif must be sheltered and succoured.

III. The child must be the first to receive relief in times of distress.

IV. The child must be put in a position to earn a livelihood and must be protected against every form of exploitation.

V. The child must be brought up in the consciousness that its talents must be devoted to the service of its fellow-men.'

It is only too easy to point to examples of deliberate violation of every one of these fundamental principles on a scale that could hardly have been conceived by previous generations. But it should also be remembered that in most countries there has at the same time been a growing body of opinion which has realized that healthy children are a necessity to the community as individuals and not only as potential atom-fodder or cheap labour; that every child should have the opportunity of physical, spiritual, and social development as a right; and that the existence of large numbers of 'insecure' and 'under-privileged' children is a criticism not only of the parents but of the community as a whole. In Britain, even the most harassing of the recent war years were remarkable for the consideration given to child health in the national effort; this realistic attitude to the vital importance of children to the community achieved results in a time of emergency which showed how much could be done even under the most adverse circumstances. Apart from the nation-wide evacuation of children from the large cities, which was on the whole carried through with singular success, infantile mortality in England and Wales fell to the lowest recorded level, and in spite of a reduced national food supply the majority of children were in fact better fed than they had been previously. The National Milk Scheme of 1940 and the rapid growth of the school meals service were achievements of outstanding importance, whilst the Education Act passed by Parliament in 1944 not only extended the principle of opportunity according to ability far in advance of the previously existing system, but also accepted a much wider responsibility for the health and nutrition of school children by the State. Against these advances must unfortunately be set the increased number of broken homes and divorces, the rise in the illegitimate birth rate, and the spread of tuberculosis and syphilis, to mention only a few of the handmaidens of war.

The Future

At the present time we are embarking on a period of social reconstruction in which the services devoted to child health and welfare are likely to occupy an increasingly important place. Without entering into administrative details, which are likely to involve an overhaul of the whole system of local government, certain general principles of future planning may be stated.

(1) A much closer integration of the services dealing with health and sickness is essential. The two have developed to a large extent independently, with the result that there is often little co-operation or understanding between the antenatal and maternity units, the children's hospital, the welfare centre, and the school medical service, whilst there is often unnecessary overlapping between the almoner or social welfare services of different voluntary and municipal bodies. In some centres it has already been found that the university department or institute of child health can provide the connecting link, and be staffed jointly by representatives of the children's hospital and the child health services.

(2) Both the hospital and public health services must be rendered more accessible and helpful to the practitioner who will remain responsible for domiciliary visits, and is likely to be consulted over the bringing up of healthy children.

(3) The Child-Health Visitor should play an important *rôle* in the future service, since it is her function to carry health education into the home and serve as liason between practitioner, health centre, and hospital.

(4) Greater emphasis must be placed on health and normal development in the teaching of pædiatrics ; this applies not only to the training of doctors but also to that of nurses and health visitors. A too-exclusive concentration on disease in childhood has been partly due in the past to the material of child health being scattered over home, school, and welfare-centre, and being largely inaccessible for teaching purposes. The institution of health centres, where newborns, infants, and school children could be seen conveniently grouped would do much to remove this difficulty (McNeil, 1945).

(5) A unified system of individual records which would start with the obstetric history, follow the child through welfare centre, nursery and school, and be available if required to practitioner or hospital, would, in spite of the administrative difficulties involved, save much duplication of work and in the long run make for greater efficiency. The individual record should ultimately pass to the medical officer attached to the juvenile employment bureau.

(6) The question of unified responsibility for the health and welfare of children is at last being faced. Up to the present we have had the chaotic situation that no less than seven different ministries have been responsible for children (see Chapter XVIII), in addition to a very large number of voluntary organizations and local authorities. The Children Bill (1948) now promises an administrative machinery for improved child care, and should serve to remove at least some of the anomalies of the existing system. But whilst legislation may serve as a crude index of public enlightenment, its direct repercussions on the child will depend on the manner in which its provisions are implemented, and, in the last analysis, on the human relationship between the child and those directly responsible for his care.

R. W. B. Ellis.

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PART I

DEVELOPMENT

CHAPTER I

ANTENATAL AND INTRANATAL CARE

(1) Antenatal Care

ANTENATAL care has two main objects. First, to conserve the health of the expectant mother in pregnancy, labour and the lying-in period, and secondly, to enable her to produce a healthy child with the highest possible potentiality of developing into a healthy adult.

In this chapter will be considered the care of the expectant mother in so far as it influences the well-being of the child. Usually the interests of child and mother are compatible but they may not be so. It may, for example, be necessary to terminate pregnancy before viability of the fœtus in order to save the life of the mother as in severe vomiting of pregnancy, or certain serious forms of heart disease. With modern advances in treatment such instances are, however, becoming comparatively rare.

The First Examination. Nowadays the first antenatal examination usually takes place early in pregnancy, as soon as the woman knows that she is pregnant and therefore soon after the first or second missed menstrual period. The general lines of the examination at this time will be apparent from the record form reproduced herewith.

ANTENATAL RECORD

In-Patient No................ Antenatal No........
Name...................... Age .... Date ....
Address .... Name and Address of friend ....
....
Date of Marriage......................................
Menstrual history : Age at puberty........Type of cycle........
First and last day of L.M.P..... Estimated date of delivery....
Date of fertile intercourse if on one occasion only................
Was a calendar kept ? (If so, try to procure it and affix to this record)..................................
Arrangements for confinement : At home.... In hospital........

Family history (T.B., multiple births, health of parents and other near relations and cause of death)

Personal history (Rickets, tubercle, rheumatism, sore throats, scarlet fever, diphtheria, heart disease, kidney trouble, operations, etc.).

History of present pregnancy : Vomiting.... Headache........

Swelling............ Constipation...... Other conditions........

Bleeding............ Heartburn............

HISTORY OF PREVIOUS PREGNANCIES AND LABOURS (INCLUDING ABORTIONS)

Date of birth or abortion, year and month	Place of birth	Duration of pregnancy in weeks	Abnormalities in pregnancy	LABOUR			Puerperium	CHILD					
				Spon.	Inst.	Complications		Born alive or dead	Sex	Birth weight	Breast feeding	State of health now	Age at and cause of death

First Examination Date.......... Made by..........

General Nutrition : Stout, thin, average. Height.... Weight....

DIGESTIVE SYSTEM : Teeth...... Other abnormalities.....

CIRCULATORY SYSTEM : Heart...... Blood pressure........

Varicose Veins........ Œdema.......

Anæmia (blood count and H. B. estimation if anæmic)...............

Other abnormalities ....

RESPIRATORY SYSTEM : Lungs............. Cough........

Other abnormalities................

NERVOUS SYSTEM : Pain, tingling, numbness, cramp (state site) ....

Other abnormalities ....

DUCTLESS GLANDS : Abnormal distribution of hair........

Other abnormalities...............

INTEGUMENTARY SYSTEM :...............................

URINARY SYSTEM :

Frequency........... Pain.......... Remarks.........

Urine : Reaction.... Sp. Gr..... Albumin*....... Sugar....

SKELETAL SYSTEM : Evidence of rickets.....................

Other abnormalities...................

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* If albumin is present a catheter specimen must be taken and only the result of that entered.

PELVIS : I.S.................. Transverse of outlet...........
I.C.................. Pubic Arch..................
E.C.................. Type of pelvis................
D.C.................. X-ray........................
Estimated C.V....................................

OBSTETRICAL EXAMINATION

Duration of pregnancy in weeks...... Breasts...... Nipples.....
ABDOMEN : Height of fundus (cm)......Presentation and position ....Presenting part : Above brim, engaging, engaged. Fœtal heart sounds (point of maximum intensity).
VAGINAL EXAMINATION.......................................
VAGINAL DISCHARGE : Character........

Result of Smears { Cervix { Urethra ..Wasserman Test { Date....... { Result......
Pathological Reports : Return on..........

SUBSEQUENT ANTENATAL EXAMINATIONS

Date	Height of fundus	Presentation and position	Relation of presenting part to brim	Fœtal heart sounds	* Urine -	B.P.	Weight	Œdema (give site)	Remarks	Return on	Initials of Examiner

* See footnote on p. 16.

The General and Family History. Accurate ascertainment of the date of the first and last days of the last menstrual period, as well as of the ‘ type,’ *i.e.*, duration and regularity of the periods, are important in regard to accurate estimation of the duration of the pregnancy. This may be of great importance later if any question of premature termination of pregnancy is to be considered, for the child’s chances of survival are much greater if intra-uterine life can be prolonged until the end of the thirty-seventh week (259 days) counted from the first day of the last period. Though in the record form the date of fertile intercourse is included, this is only in order to collect data for research purposes, and even though the date is known it does not influence any conclusion regarding the duration of pregnancy or the time at which pregnancy may with safety for the child be interrupted. The 'history of the present pregnancy' should include in addition to the abnormalities listed an enquiry as to whether the woman has suffered from rubella or other infectious disease, either since her pregnancy started or shortly before. The investigations of Gregg, of Sydney (1941) and Swan *et al.* (1943–44) have shown that the infants born of women who had suffered from rubella (German measles) in early pregnancy were liable to have certain congenital defects including congenital cataract (unilateral or bilateral), microcephaly, congenital heart disease, deaf mutism, obliteration of the bile ducts and mental backwardness. The rubella had occurred almost invariably in the first three months of pregnancy, but in one case it had occurred at the fifth month (deaf mutism) and in another at the sixth month (microcephaly), and in still another three months before pregnancy began. In two of Swan's cases in which the rubella had occurred at the sixth month the infants did not show any defect. Swan concludes: 'On the available evidence, when a woman contracts rubella within the first two months of pregnancy it would appear that the chances of her giving birth to a congenitally defective child are in the region of 100 per cent., and if she contracts rubella in the third month they are about 50 per cent.; there is still slight likelihood that the child will be congenitally defective if rubella is contracted after the third month of pregnancy.' The cause of rubella is unknown, but is believed to be a filterable virus and that it has a special predilection for embryonic tissues. So far as is known, ordinary measles (morbilli) does not cause congenital defects; but the evidence on this point is so far incomplete. Swan reported one case of bilateral corneal opacities in which the mother had had mumps when three and a half to four months pregnant. In New York, Reese (1944) reported three cases following rubella in the first month of pregnancy. Nine cases have been reported by Albaugh (1945), also in the United States, and in England one case has been reported by Hughes (1945).

It is said that the epidemic of rubella which occurred in Australia in 1940 was an unusually severe one, the virulence of the disease being possibly due to overcrowding by the influx of military recruits, that it is possible that congenital defects are not caused by the ordinary mild disease and that this may explain the fact that a relationship between rubella and congenital abnormalities had not been noticed before. However that may be, it is evident that in antenatal clinics a careful history must in future be taken with special reference to any infectious disease, including particularly German measles and mumps from which the mother may have suffered in the period immediately before pregnancy, or during pregnancy, noting as far as possible the nature of the illness and the time when it occurred. A similar scrutiny of the history should be made in all cases of congenital abnormality. This is necessary in order to collect data as to whether rubella always causes congenital abnormality if contracted in early pregnancy, a matter about which we have as yet little information.

History of Previous Pregnancies and Labours. It is always important to get detailed information regarding any previous pregnancies and their results. It may reveal a tendency to habitual abortion, still-birth or neonatal death when a search for the cause will become an important part of the antenatal investigation. This may reveal that the cause is syphilis, rhesus antibodies, difficult labours due to contracted pelvis, etc. Time is well spent that gets an accurate history in this respect set down in proper chronological order.

The General Medical Examination. This involves an examination of the various systems and should never be neglected as it may influence materially the management of the pregnancy and labour. Routine weighing is advisable, for an excessive increase in weight due to occult œdema may be one of the earliest signs of pre-eclamptic toxæmia. The stature should be measured, for short statures (below 5 feet) may indicate some form of contracted pelvis, though in short women the pelvis may be normal. For the same reason examination for signs of rickets should never be neglected though it must not be forgotten that rickets may not leave any manifest changes except in the pelvis and that failure to find evidence of that disease elsewhere does not necessarily exclude rickety pelvic contraction of minor, but clinically important, degree.

The heart should be examined, and if there is suspicion of serious disease it is best to refer the patient to a cardiologist if one is available. Very rarely indeed will it be necessary to terminate pregnancy for such a condition in the early months but it is always advisable to see that the patient's activities during the pregnancy are adjusted to her tolerance especially in the later months, and to admit her to the antenatal ward for rest and care two weeks before the expected date of delivery. The lungs should be examined for any evidence of tuberculosis which is especially liable to be missed in early pregnancy when loss of appetite and debility are apt to be put down to the nausea natural at this time. No doubt the time will come when chest radiography will be routine in antenatal clinics for there is no doubt that many cases of early pulmonary tuberculosis are there overlooked. Yet early diagnosis is all important in order that treatment in the best conditions can be undertaken at the earliest possible time.

The blood pressure should be estimated by the auscultatory method. Standards of normality vary widely but the tendency in recent years has been to lower the standard very considerably. In the obstetric unit, University College Hospital, we take 120/80 as the upper limit of the normal, irrespective of the patient's age. Neither do we discard a high first reading as of no importance, for instability of blood pressure as indicated by a rise of systolic pressure to a high level from nervousness may be an early warning sign that at a later date in her pregnancy the patient will develop pre-eclamptic toxæmia with hypertension. If chronic hypertension exists early in pregnancy, *i.e.*, before the twentieth week, the outlook for a successful pregnancy depends on how marked the hypertension is. If at the beginning of pregnancy the blood pressure is 150/100 or over, experience shows that the chance of producing a live child is only about 30 per cent., though the chances are much increased by adequate supervision, and care in hospital if necessary. A hæmoglobin estimation should probably be routine and certainly should not be omitted if there is suspicion of anæmia. Examination of the urine is no less important than estimation of blood pressure and if albumin is found at this early period, *i.e.*, before the twentieth week, it may indicate the presence of chronic glomerular nephritis, a condition in which the advisability of allowing pregnancy to continue may be rightly called in question. Before deciding that there is albuminuria, however, it is always necessary to examine a catheter specimen, for a vaginal discharge may so contaminate a voided specimen of urine as to add to it even a considerable quantity of albumin. If the presence of albumin is confirmed it will generally be advisable to admit the patient to a hospital bed for observation and investigation of kidney function. If sugar is found in the urine its cause must be investigated. Is it lactose or glucose ? If glucose, it may be of no importance or may mean that the patient has diabetes mellitus. The patient may, of course, be known to be a diabetic. Otherwise diagnosis will depend on repeated examinations of the urine, estimating the fasting blood sugar, and on sugar tolerance tests. Sugar tolerance tests must, however, be cautiously interpreted during pregnancy for a delayed tolerance test is normal during pregnancy, and it may not be possible to arrive at a diagnosis for some time after delivery.

Pelvic Measurements. These should never be omitted, even the external measurements. For though one would never rely on the latter to exclude minor degrees of pelvic contraction, nevertheless abnormal measurements serve as a warning and indicate the necessity for accurate pelvimetry by X-rays. It should be remembered, however, that apparently normal external measurements are quite compatible with a contracted pelvis. Measurement of the diagonal conjugate is not advisable before the thirty-second week and it is only necessary then or later if pelvic contraction is suspected. In all cases in which it is suspected it is, however, nowadays considered advisable to measure the pelvis accurately by X-rays—one of the great advances of modern obstetrics. In regard to this it is important to remember that recent investigations have shown that in England the average true conjugate diameter of the pelvic inlet measures 4½ inches, not 4¼ inches or 4 inches as formerly believed.

In the X-ray pictures two views are shown, a lateral and an anterior. In the lateral the antero-posterior diameter of the true pelvis at all levels can be measured, and the inclination of the brim and the contour of the sacrum seen. In the anterior view the general shape of the inlet, its transverse diameter, and in favourable cases, the transverse diameter of the outlet, *i.e.*, the distance between the ischial spines, measured. If the picture is taken at term it may be possible to assess the relative sizes of fœtal head and pelvis and thus decide whether disproportion is present or not.

Obstetrical Examination. It is always well to begin this by estimating the duration of the pregnancy counting from the first day of the last menstrual period and recording it in weeks. It will thus be seen at once whether the size of the uterus, ascertained either by external or internal (bimanual) examination corresponds. This may be very important later on if the abdomen is too small or too large for the period of amenorrhœa, or if there is a question of postmaturity, and the accuracy of the menstrual dates is called in question. Additional valuable information in this connection may be afforded by the record of the height of the fundus at the first examination.

If, as is now usual, this first examination is carried out not later than the third or fourth month, the abdominal palpation, auscultation, etc., that is routine in later months is neither possible nor necessary. Here, for purposes of description, we shall assume that the pregnancy has reached the later weeks, say, the thirty-eighth, by the time this first examination takes place. By this time the fœtus should have settled down into its final position, it should be possible to diagnose the presentation and position accurately, to determine the relation of the head to the pelvis, if the head is presenting, and to assess with a fair degree of accuracy the prospects for the forthcoming labour. It is not our purpose here to describe methods of diagnosis in detail. Such details may be found in obstetric text books and can only be learnt by practice. Two important matters may, however, be emphasized. In the first place the patient should have been examined at or about the thirty-second week to exclude breech presentation. If a breech presentation is found it is usually advisable to perform prophylactic external cephalic version within the two weeks following. This is especially necessary in the primigravida in whom breech delivery entails a much increased risk of fœtal death or injury. If attempts at version fail it is the medical attendant's duty to ascertain accurately the pelvic capacity. If it is contracted, delivery by Cæsarean section should be given full consideration. Secondly, it is an elementary rule in obstetrics that in a primigravida the fœtal head should be engaged in the pelvis (*i.e.*, its widest diameter should have passed the brim) at the end of the thirty-eighth week. If the head is free above the brim it should be regarded as abnormal and an attempt made to find the reason for the abnormality. Well-known reasons are: a loaded pelvic colon, an occipito-posterior position, contracted pelvis or disproportion, pelvic tumour, placenta prævia, multiple pregnancy, and hydramnios, but in about 20 per cent. of all cases no cause can be found.

A vaginal examination should be made in all cases at this first visit. This is in order to exclude pelvic tumours, especially ovarian cysts, which might otherwise remain undiscovered until the pedicle became twisted, or they obstructed labour. Another reason is to discover and treat any abnormal vaginal discharge. If this were due to an undiagnosed gonorrhœa it might infect the child's eyes at delivery.

In every antenatal clinic the Wassermann test should be a routine procedure. This is because pregnancy in some way modifies the clinical signs and symptoms of syphilis so that the presence of the disease may be overlooked. If the test is positive it should, if there is any reason to doubt the accuracy of the result, be repeated on the woman and her husband. The Wassermann test should not, however, be relied on entirely for diagnosis. The history should be examined. A history of syphilis may be absent even though the woman gives birth to syphilitic infants. The obstetrical history may arouse suspicion, *e.g.*, of repeated dead and macerated fœtuses or neonatal deaths, though so far as we know syphilis does not cause early abortion, *i.e.*, before the twenty-fifth week. Clinical signs of syphilis may be present in the form of primary, secondary or tertiary lesions, the last in the form of scars of healed gummata especially over bony sites such as the shins, arms, shoulders, forehead and nose. If syphilis is diagnosed a full course of treatment according to modern standards should be given. Needless to say, the child should be kept under strict supervision until adolescence. At the same time as blood is taken for the Wassermann test sufficient can also be obtained for testing the rhesus factor which is already a routine procedure in many clinics. If the woman is rhesus negative her husband should be tested. If he is rhesus positive the wife's blood should be examined for antibodies at monthly intervals. If they are present the advisability of Cæsarean section or induction of labour at the thirty-seventh week may be considered in the interests of the child, but if there is *hydrops*

FORM FOR RECORDING RHESUS RESULTS

(From Browne, F. J., 1946, 'Antenatal and Postnatal Care', 6th Ed., J. & A. Churchill.)

This patient (Mrs...............) is rhesus negative. The following precautions are to be taken :—

(1) Her husband's blood is to be tested for rhesus factor and result recorded below.

(2) Samples of the wife's blood are to be examined for antibodies monthly throughout pregnancy, and results recorded below.

(3) If the husband is rhesus positive and antibodies are present, the infant is to be transfused immediately after birth with compatible rhesus negative blood, preferably through the umbilical cord.

(4) Should the wife need transfusion either before or after delivery, only compatible rhesus negative blood is to be used. If this is not immediately available, serum or plasma should be given until rhesus negative blood is obtained.

(5) A sample of blood from the infant at birth, and before transfusion, preferably from the cord, is to be examined for evidence of erythroblastosis.

(6) A sample of mother's blood to be examined again for antibodies after delivery.

Results of Tests

Husband's Blood

Date..
Result ....

Antibodies in Wife's Blood

Date..
Result ....
Date..
Result ....
Date..
Result ....

fœtalis Cæsarean section is contra-indicated as the child is unlikely to survive. Whether the child is delivered prematurely or not preparation should be made to transfuse it immediately after birth and preferably through the umbilical vein with rhesus negative blood—not that of the mother. We have introduced a simple form for rhesus results that is designed to help accurate recording in spite of frequently-changing junior staff.

Frequency of Examination. Such in outline is the routine of the first examination. At its conclusion the woman is given advice regarding the hygiene of pregnancy, and an appointment made for her next interview. She should in normal cases be seen once every month until the thirtieth week, every second week from the thirty-second till the thirty-sixth week and weekly from then till delivery. Between the first visit and the twenty-second week it is unnecessary to do more than interview the patient, weigh her, examine for clinical œdema and test the urine and blood pressure. At the thirty-second week breech presentation must be excluded, and from the thirty-sixth week till delivery the lie of the fœtus and the relation of the head to the pelvis are observed at each visit. A careful watch should be kept for any of the early signs of pre-eclamptic toxæmia, such as abnormal œdema, hypertension or albuminuria. Should they appear, or any one of them, suitable advice will be given or it may even be necessary to admit the patient to hospital for observation and care. If this is not done she should be seen again in a week, for ominous signs may develop with extraordinary rapidity.

Diet in Pregnancy

At the end of the first interview advice will be given regarding the hygiene of normal pregnancy. Such matters as diet, clothing, sleep, care of the breasts and teeth, etc., will be discussed as well as the preparations for confinement. It is usually wise to give the woman some simple printed directions which she can have always available and can study at leisure.

It is generally agreed that there is no need to increase the quantity of food in pregnancy. The League of Nations Technical Commission took 2,800 calories as the daily requirement of an adult female whether pregnant or not. The carbohydrate and fat in the diet may be allowed to look after themselves but the diet should include about 100 g. daily of protein, *i.e.*, 2 g. per kilo of body weight as compared with 1 g. per kilo in the non-pregnant woman. There is little concrete evidence that diet has any influence on the weight of the human infant though Prochownik in 1889 recommended a reduction in the allowance of carbohydrates and fat in the last six weeks in order to minimize the deposit of fat in the subcutaneous tissues and thus reduce the weight of the baby at birth (see also Chapter II, p. 142). At least half the protein should be 'first class,' *i.e.*, derived from animal sources, milk, eggs and meat, the protein of which has a higher biological value in that it contains certain essential amino-acids which the body itself cannot synthesize.

The diet should also contain sufficient minerals, especially calcium, phosphorus and iron and sufficient vitamins, especially vitamin D, to meet the needs of the mother and of the developing fœtus. Dietetic deficiencies may cause certain abnormalities in the mother, about which comparatively little is known, and with which we are not here directly concerned. On the other hand, considerable information has been accumulated regarding their influence on the health of the child and particularly on the structure and development of the bones and teeth. The investigations of the Mellanbys in Britain and of Maxwell in China have been especially valuable in demonstrating the supreme importance of an adequate supply of calcium, phosphorus and vitamin D throughout pregnancy and during infancy and childhood. In cases of extreme deficiency of these substances rickets may even be present at birth (Maxwell; Toverud and Toverud, 1931). It is more common, however, to find that the child is born with a predisposition to rickets, a predisposition that may not always be capable of being overcome by good postnatal feeding. This was shown by Mellanby (1929), who found that if bitches are fed during pregnancy on a diet that in puppies will lead to rickets the offspring have a greater tendency to develop rickets and this tendency was not removed if the puppies were fed on a good diet.

Hypoplasia and defective calcification of the enamel and dentine of the teeth is another consequence of calcium—phosphorus and vitamin D deficiency. The calcification of the deciduous teeth takes place from the seventeenth week till the end of pregnancy while that of the permanent teeth takes place partly in the latter part of pregnancy, partly during suckling and partly in childhood. In the absence of vitamin D even the presence of large quantities of calcium and phosphorus in the diet does not, according to M. Mellanby, result in perfectly formed teeth and jaws. A deficiency of this vitamin in the mother's diet during pregnancy and lactation, especially with a low intake of calcium, caused the deciduous or milk teeth, and to a less extent the permanent teeth of puppies to be imperfectly calcified, even when after weaning their own food contained abundance of these substances; if the puppies continued on the same defective diet as the mother had had, their permanent teeth were very badly formed. It was indeed possible to produce at will perfect and imperfect teeth by small variations in the diet of the experimental animals during the period of tooth development. If calcification is defective, resistance to caries is much diminished. Toverud and Toverud found that the children of mothers who had taken less than half a litre of milk during pregnancy showed twice as much caries as the children of women who during pregnancy had a high milk, vegetable and fruit diet. They assert, too, that while in their opinion a predisposition to rickets might be overcome by good postnatal feeding, hypoplasia of the enamel and dentine could not be so remedied.

Mellanby brings forward evidence to show that catarrhal conditions of the respiratory tract such as broncho-pneumonia are more frequent in the offspring of mothers whose diet during pregnancy had been deficient in fat soluble vitamins.

The fœtus at term contains about 30 g. of calcium and 18 g. of phosphorus which are chiefly laid down in the last three months. Toverud and Toverud estimate that from 1·6 to 1·9 g. of calcium and from 1·8 to 2 g. of phosphorus daily must be ingested to ensure sufficient retention to meet the needs of the fœtus and prevent a negative balance in the mother. Milk is the richest source of calcium, and about 70 to 80 per cent. of the calcium in the diet is derived from it. One litre of milk contains 1·2 g. of calcium and therefore about 1 quart daily (1,200 c.c.) giving 1·4 g. is necessary with other calcium-containing foods to ensure a sufficient intake. Besides the calcium and phosphorus in milk are in the most suitable form to ensure retention. Other less important sources of calcium are oatmeal, fruits, vegetables and green leaves. It can, of course, also be supplied in the form of soluble salts, such as calcium lactate, but it is best given in its natural form as in the above-named foods, which contain other valuable food factors in addition. Foods rich in phosphorus are milk, cheese, egg yolk, lean meat, liver, whole meat, oatmeal, beans, spinach, brussels sprouts and potatoes. In whole wheat most of the phosphorus exists as phytin which forms insoluble and unabsorbable calcium salts. It has been found that by fortifying the whole wheat flour with calcium carbonate the phytin is precipitated and the absorption of calcium is thus improved (McCance and Widdowson, 1942) and this is now done in the national loaf (7 oz. to 280 lb. of flour). In regard to oatmeal the experimental results are not conclusive. The data of Steggerda and Mitchell (1939) showed that calcium absorption was not interfered with by the phytin of oatmeal while Cruickshank and his co-workers (1943) found that of four adults tested two showed normal and two subnormal absorption, a result which suggests that the influence of phytin varies with different cereals.

Data collected in recent years and in various countries show that the calcium intake of the pregnant woman rarely reaches the optimum mentioned above. Toverud and Toverud found that in a hundred pregnant women in Oslo it seldom exceeded 1 g. and was usually not over 0·6 to 0·7 g. Coons and Blunt (1930) in U.S.A. found that in eight out of nine pregnant women it was under 1 g. daily. Orr (Food, Health and Income, 1936) estimated the average calcium intake among the pregnant poor in Edinburgh as 0·37 g. daily. McCance and Widdowson investigated the diets of a hundred and twenty pregnant women in Britain at different economic levels varying from unemployed miners to professional classes. The women were classified into six groups according to the amount of money available weekly for food per head of the family as follows :

(1) Less than 6*s.* ; (2) 6*s.* to 9*s.* ; (3) 9*s.* to 15*s.* (4) 15*s.* to 25*s.* ; (5) 25*s.* to 40*s.* ; (6) over 40*s.*

It was found that the intake of calories was little affected by income, but the consumption of milk, fruit, vegetables, meat and fish rose with income. The intake of total protein and of animal protein rose with income and no serious protein deficiency occurred if the weekly income per head less rent was over 25s. Fat consumption was high even among the poorest women due to the fact that bread and butter and margarine formed a large part of their diet ; neither was there any constant effect of income on the carbohydrate intake. Intake of calcium, phosphorus and iron rose with income but the average intake even of the well to do was much below probable requirements, and only one of the hundred and twenty women was taking enough calcium and phosphorus. Among the three lowest income groups the intake was less than one-third of requirements. That of iron was suboptimal in all, *i.e.*, below 20 mg. daily. It was not found possible to estimate the intake of vitamin A, C and D and of most of the B complex.

The advice is commonly given to expectant mothers to 'eat what you are used to,' or to 'take a good mixed diet.' This investigation by McCance and Widdowson shows how inadequate such advice is !

It should not be forgotten that while an adequate diet is necessary in pregnancy it is just as necessary during lactation and for the child after weaning and until adolescence. It should also be recalled that while vitamin D is present in milk, butter, cheese, eggs and vitaminized margarine it is on the whole a scarce vitamin in habitual foods, especially in northern countries in the winter months, and that to ensure an adequate supply of it it is necessary to supplement the diet by fish liver oil. Two teaspoonfuls of cod-liver oil should be taken daily throughout pregnancy and lactation, or an equivalent amount of halibut oil.

A recent investigation by Mellanby and Coumoulos (1944) suggests that improvements in the diet of pregnant women and nursing mothers and of infants and young children consequent on the cheap milk scheme and later on the war-time food policy which includes (*a*) increased allowances of milk together with cod liver oil and fruit juices to pregnant and lactating women, to infants and to young children : (*b*) the addition of vitamins A and D to margarine and (*c*) the addition of calcium carbonate to bread, are already resulting in improvement in the condition of children's teeth. In 1943 the teeth of a large group of five-year-old children attending L.C.C. elementary schools were examined and compared with the results of a similar investigation in 1929 in Sheffield and Birmingham. This showed that in the intervening period a significant improvement had taken place both in the structure of the deciduous teeth and in their resistances to caries as is shown in the following table :—

TABLE 1

INCIDENCE OF DENTAL CARIES IN DECIDUOUS TEETH (Mellanby and Coumoulos)

	Total No. of Children.	Percentage of children showing:			
		No Caries	Little Caries	Some Caries	Much Caries
1943 .	1,604	22·4	25·9	22·4	29·3
1929 .	1,293	4·7	11·7	20·8	62·8

Effect on the Child of Deficiency of other Vitamins. Little is known about the effects on the child of deficiency of vitamins other than vitamin D. Maxwell (1932) reported that keratomalacia occurred in the children of mothers whose diet had been deficient in vitamin A and concluded that this had been contracted *in utero*. Hale (1937) found that sows fed on a diet deficient in vitamin A before and during the first thirty days of pregnancy gave birth to offspring with various eye defects. In some one or both eyes were absent. Some had one large and one small eye and all were blind. There were other defects present as well, such as accessory ears, ectopic kidneys and harelip and cleft palate. If blind pigs from these litters were mated with each other and fed on rations containing vitamin A, normal pigs resulted, proving that the dietary defect and not heredity was the cause. It is said that the infants of women who have suffered from beri-beri during pregnancy are affected by polyneuritis or may be born dead or suffer from hæmorrhages soon after birth (Moore and Brodie, 1927 ; Huggett, 1944). Warkany *et al.* (1944) produced congenital abnormalities, including shortening and distortion of the extremities, syndactylism of the hands and feet and eye defects in the offspring of rats that had been fed on a rickets-producing diet to which vitamin D had been added. The abnormalities could be prevented by adding riboflavin to the diet. Pregnancy in the rat lasts twenty-two days and to prevent the malformations the preventive factor must be added before the fourteenth day. Deficiency of vitamin C is very apt to occur in pregnancy, as the body has little power of storing it, and may lead to abortion or absorption of the fœtus in experimental animals, and the child may be born with scurvy, with hæmorrhages in the joints and internal organs. Gross deficiency of vitamin E, sometimes called the ‘ anti-sterility vitamin,’ causes abortion or absorption of the fœtuses in rats, and for this reason it is much used in the treatment of habitual abortion in women. Its value in this respect has, however, never been established and it is doubtful whether any important deficiency ever occurs in human pregnancy. Vitamin K is in some way necessary for the formation of plasma prothrombin which is an essential factor in blood clotting. In premature infants this is only about 11 per cent. of that of the adult (Hellman and Shettles, 1939) and these may be in consequence unduly liable to birth hæmorrhages. Many authorities, therefore, advocate giving vitamin K to the mother for a month or so before the artificial premature termination of pregnancy or during spontaneous premature labour in order to raise the prothrombin level. As the prothrombin level in full time infants is also much lower than that of the adult—11 per cent. to 39 per cent. (Brinkhous, Smith and Warner, 1937), attempts have been made to diminish the incidence of birth hæmorrhages in them also by the administration of vitamin K during labour (Hellman, Shettles and Eastman, 1940) but the results so far obtained are equivocal. There is evidence that many anæsthetics and analgesics including nembutal, phenobarbitol and other barbiturates, depress the prothrombin levels in mother and child by damaging the liver, in which prothrombin is formed.

Effect on the Child of Deficiency of Minerals other than Calcium and Phosphorus

Iron. The liver of the newborn child at term contains weight for weight five times as much iron as that of the adult. As the iron content of milk is poor this may be a provision for the early months of postnatal life. These stores are laid down chiefly in the last three months of pregnancy and in the last two months the iron content of the fœtus increases from 80 to 400 mg., which amounts to a storage of 5 mg. daily. Premature infants are therefore born with a subnormal amount of iron and so are prone to develop anæmia (Davidson and Leitch, 1934). The average diet in Britain contains 10 mg. of iron daily, whereas 20 mg. are necessary to supply the needs of the fœtus and prevent a negative balance in the mother. Much can be done to ensure this by foods rich in iron such as liver, kidney, lean red meat, dried fruits, eggs and green leafy vegetables, especially spinach and the usually despised turnip tops. Should a proper diet be unobtainable iron should be given medicinally and this should always be done in any case if the hæmoglobin is below 90 per cent.

Iodine. It has been shown by E. Mellanby that a diet deficient in this substance may, in animals, if continued through several pregnancies, lead in the offspring to simple goitre. He believes that the development of simple goitre in later life may be prevented by the supply of an adequate amount of iodine (0·1 mg. daily) to the mother during pregnancy and lactation. This can be ensured by eating sea-fish twice weekly, or by fish-liver oil, the use of which should be continued throughout childhood and adolescence.

Other Minerals. Little is known about other mineral requirements in pregnancy though it is probable that several, such as copper (which may be necessary for the development of the red blood corpuscles), sodium, potassium, manganese, magnesium and sulphur are important. Studies of sodium potassium and sulphur balances have shown that the intakes of these substances are usually adequate for the fœtal needs.

Within recent years some large scale clinical experiments have been carried out with the object of assessing the value of dietary supplements in pregnancy in diminishing the incidence of abnormalities in the mother and on various matters affecting the child. On the whole, though large claims have been made, the results have been unconvincing. Two of these experiments, that of the

Toronto workers, Ebbs, Tisdall and Scott (1941), and that of the People's League of Health, London, were well controlled and that of the latter was on a large scale. Both these groups of investigators agreed (1) that there was no significant increase in the weight of the infants at birth (2) that the incidence of prematurity was reduced. The Toronto workers claimed in addition that the frequency of miscarriage was diminished and that 250 of the infants followed up for six months after birth showed a lower incidence of colds, bronchitis, pneumonia, rickets, anæmia, etc., and a lower mortality rate. The figures have, however, been subjected to considerable criticism and it is evident that more large scale experiments of the same kind are necessary before the claims put forward can be considered firmly established.

As a general guide to diet in pregnancy and lactation Mellanby advises the following:

Two pints of milk daily.

One or two substantial servings of green vegetables, cabbage, spinach or lettuce daily.

One or two eggs or egg yolks daily.

An apple or orange or some fresh fruit daily.

Sea-fish twice or more a week.

Calf's liver once a week.

If cod-liver oil can be taken, two teaspoonfuls daily are advisable. Halibut-liver oil is equally good and has the advantage that it is smaller in bulk and can be taken in capsules, each of which contains 2 minims.

The rest of the diet can be made up as the woman wishes.

Indoor Antenatal Care. Every antenatal clinic should have at its disposal a certain number of beds to which patients who need special investigation, care or treatment can be admitted. Examples are patients suffering from the more severe degrees of pre-eclamptic toxæmia, chronic hypertension in pregnancy, chronic glomerular nephritis complicating pregnancy, hyperemesis, pyelitis, cardiac disease, antepartum hæmorrhage. It has now, for example, become almost a universal rule in obstetric practice to admit every patient who has any antepartum hæmorrhage no matter how slight, *and to keep her in hospital till delivery.* Except when the hæmorrhage is severe the cases can be treated expectantly, allowing the pregnancy to continue till term or at least until the child is viable. By such conservative institutional treatment the combined fœtal and neonatal mortality is being much reduced—even to as little as 20 per cent. and the maternal mortality is less than 1 per cent., compared with about 60 per cent. and 6 per cent. respectively a few years ago. Similarly with pre-eclamptic toxæmia, with early diagnosis and treatment and admission of the more severe cases to hospital for rest and care the incidence of fœtal death and premature birth are being much reduced, while eclampsia is in many clinics seldom seen. Antenatal care has transformed the practice of obstetrics within the last twenty years and the two examples last mentioned are amongst its greatest triumphs.

(2) Intranatal Care

Here again we shall consider the subject from the point of view of the child rather than from that of the mother. As in antenatal care the interest of the child and of the mother usually coincide but again not always. It may, for example, be necessary, though much more seldom than even a few years ago, to destroy the fœtus in order to save the mother's life. A full consideration of intranatal care even in the restricted sense above mentioned would embrace almost the entire conduct of labour from its commencement until the birth of the child, and would not be possible in the space at our disposal. Let it suffice, therefore, to emphasize some general principles, bearing in mind that good intranatal care is inseparably dependent on good antenatal care by means of which difficulties are foreseen and measures directed to their prevention instituted.

The Premature Infant. Though only about 3 per cent. of all births are premature, prematurity accounts for 50 per cent. of neonatal deaths, about 60 per cent. of which take place in the first twenty-four hours after delivery. The mortality rate falls as the weight of the child at birth increases and it is therefore important to delay the birth of the premature child as long as possible. It is desirable to avoid the termination of pregnancy, where this is indicated, till the end of the thirty-seventh week counted from the first day of the last menstrual period. It may not be always possible to do so, as for example when the mother has pre-eclamptic toxæmia, in severe cases of which the risk of intra-uterine fœtal death is a very serious one, and it may be considered necessary to terminate pregnancy at the thirty-fourth week or even earlier to rescue the child from its dangerous environment. Generally speaking, the child has a poor chance of survival if it weighs less than 4 lb. (1,814 g.) at birth. X-ray cephalometry should be used whenever possible to assist in estimating the weight of the fœtus before terminating pregnancy.

The respiratory centre of the premature infant is poorly developed and easily depressed, and its blood vessels being fragile, hæmorrhage occurs in its organs and especially in the brain after slight trauma or even as a result of anoxia. In the conduct of its delivery therefore it is well to avoid the use of general anæsthetics and of analgesics, especially the barbiturates and morphia or any of its derivatives. As the prothrombin content of the premature infant is low, it is advisable to administer vitamin K to the mother, preferably for four weeks before pregnancy is terminated or if that is not possible, as soon as labour starts. To avoid trauma Cæsarean section is often carried out and theoretically it should be the ideal method of delivery. In practice, however, the results are often disappointing, the child dying of respiratory failure a few hours or more after delivery. It almost seems as if by the slower birth by the natural passages the infant gains some benefit, perhaps a slowly increasing asphyxia which releases or stimulates the respiratory mechanism. If Cæsarean section is adopted the child should be delivered slowly and gently and as much blood as possible should be allowed to enter the fœtus before clamping the cord. This may be encouraged by injecting ergometrine into the uterine muscle. This, by causing the uterus to contract firmly, squeezes blood from the placenta into the fœtus and thus simulates what occurs during natural labour. While waiting for the pulsations of the cord to cease the child may be held by its feet to drain liquor amnii from its lungs and this process may be helped by the use of the mucus extractor. As for the anæsthetic, since anoxia must be avoided, local or possibly some form of spinal anæsthesia is best. If a general anæsthetic is used it should be given for as short a time as possible before the child is extracted. A clear air way should be maintained and cyanosis of the mother avoided. If delivery takes place by the natural passages, the membranes should be preserved as long as possible to protect the head from pressure. Episiotomy should be performed under local anæsthesia to minimize compression of the head by the vulval outlet. If birth of the head is delayed it should be assisted by the forceps applied laterally to the head.

The Long First Stage of Labour. Though the term 'trial labour' or 'test labour' is commonly reserved for the case in which there is some degree of disproportion in size betweeen the head and the pelvis, in a sense every labour is a trial labour because we cannot foretell what the strength and regularity of the uterine contractions will be. If they are weak and irregular and the membranes rupture prematurely the life of the child is seriously endangered because as the liquor amnii escapes and the uterus is allowed to retract more and more the placental area is diminished and with it the blood supply to the fœtus, which may in consequence perish of anoxia long before the first stage is completed. If the child is born alive it may die within a few hours or a day or two, from catarrhal pneumonia contracted *in utero* by the inhalation of infected liquor amnii or meconium. A few years ago it was customary to treat such cases, when delivery became necessary by the application of high or mid forceps after manually dilating or dividing the cervix by scissors. This procedure was fraught with danger to the life of the fœtus, whilst if the infant survived birth it might later show signs of cerebral injury. The modern tendency is to use the lower segment Cæsarean section operation, which gives better results for both mother and child. This operation is, however, unsafe for the mother if she has been infected by frequent vaginal examinations. In such cases, therefore, these should be as far as possible avoided, and, when they are necessary, they should be carried out with the most strict aseptic and antiseptic ritual. If while waiting for Cæsarean section there are signs of fœtal distress these may be alleviated by the administration of oxygen to the mother.

Application of Forceps. The obstetric forceps are dangerous instruments if improperly used. They should never be applied in a vertex presentation unless the head is in the pelvic cavity, *i.e.*, its widest or biparietal diameter having passed below the pelvic brim. Indeed, if *any part* of the fœtal head is felt on abdominal palpation the delivery is likely to be a difficult one and dangerous to the child. Neither should the forceps be applied unless the os is fully dilated and by full dilatation we mean full dilatation *between* pains. Furthermore, the forceps are meant to be applied laterally, *i.e.*, as nearly as possible over the ears of the fœtus. If they are applied obliquely or antero-posteriorly the head is likely to be crushed with serious consequences to the brain and its membranes. It should, therefore, be an invariable rule that before delivery by forceps the head should lie, or be made to lie in the antero-posterior diameter of the pelvis, if possible with the occiput anterior.

Abuse of Pituitary Extract. Pituitary extract administered during labour is liable to set up uterine spasm which cuts off the placental circulation and kills the fœtus. If the child is premature the violent contractions, followed possibly by precipitate delivery may cause serious injury to the cranial contents. Pituitary extract if used at all during labour should be used with great caution. Its use is probably only justified when the head is on the perineum, the occiput anterior, and uterine contractions weak. It should never be used when the labour is premature.

Analgesics and Anæsthetics in Labour. Most, if not all, of the analgesics and anæsthetics used in obstetrics tend to cause apnœa in the child. Snyder (1939) tested the influence of various drugs administered to pregnant rabbits and noted the effect on the respirations of the fœtus exposed in its amniotic sac. The normal fœtus has a regular respiratory rhythm of about thirty per minute though it of course draws liquor amnii into its lungs instead of air. If morphine, nembutal, paraldehyde, chloral, nitrous oxide or ether were administered the fœtal respirations were slowed and finally ceased long before full surgical anæsthesia had been attained in the mother. With cyclopropane it was, however, possible to get full surgical anæsthesia without any apparent depressing effect on the fœtal respirations. Schreiber (1938) claimed that asphyxia in infants at birth might cause permanent changes in the brain with clinical neurological manifestations. In a series of five hundred patients seen by him for cerebral symptoms, convulsions, spasticity, mental retardation, etc., he found a history of apnœa at birth in 70 per cent. of those in whom the birth record was available. The duration of the apnœa had a definite relation to the severity of the cerebral symptoms. The drugs used in one hundred and twenty-two of his cases in which they were known had been as follows: morphine, seven; morphine and barbiturates, seven; morphine, barbiturates and scopolamine, eleven; barbiturates alone, nineteen; scopolamine and barbiturates, nineteen; scopolamine alone, twenty-eight; morphine and scopolamine, thirty-one. He concluded that analgesics given in greater amount than the pharmacological dosage may in many cases be the causative factor in fœtal apnœa with resultant brain damage in the infant. It would seem, however, that it is very difficult or perhaps impossible to determine how much of the asphyxia is due to the analgesic and how much to the trauma caused by difficult, prolonged or operative delivery for the abnormal case is just the one in which a large amount of anæsthetic or analgesic is likely to be used. The premature infant, too, is very liable to cerebral hæmorrhage and apnœa even though no analgesic at all or only a very small dose is used. In one hundred and fifty-five of Schreiber's five hundred cases there was a history of breech, precipitate, twin or premature delivery, and in this group the incidence of apnœa was 72 per cent.

In support of this view that the method of delivery and the nature of the labour is more important than the analgesic, the experience of Lund (1942) may be quoted. Reviewing 1,982 cases of his own he found that all spontaneous deliveries showed the same amount of asphyxia, *i.e.*, 8 per cent., whether they got no anæsthetic at all or nitrous oxide and oxygen, ethylene, cyclopropane, chloroform or ether. He concluded that (1) nitrous oxide and oxygen, ethylene and cyclopropane, when used as analgesic agents did not materially influence the incidence of asphyxia ; (2) nitrous oxide and oxygen may be administered for long periods of time without significant effects on fœtal asphyxia ; (3) cyclopropane and other agents when used in concentrations sufficient for anæsthesia for operative delivery were accompanied by an increase in the incidence of fœtal asphyxia ; (4) the incidence of asphyxia varied directly with the duration of the anæsthetic ; and (5) prematurity, complications of pregnancy and labour, method of delivery and misuse of analgesic agents were apparently of greater significance in asphyxia than the various inhalation agents when properly administered. McMahon, on the other hand, thinks that all anæsthetic agents tend to produce anoxæmia. Even nitrous oxide and oxygen will, if its use is prolonged, cause asphyxia. In his opinion we have no ideal obstetric analgesic procedure though doctors are often stampeded into the use of these drugs by lay pressure. Patients should, he says, be told that there is no such thing as a safe and painless delivery.

Kotz and Kaufman (1939) studied (1) the mortality rate, (2) the initial loss of weight, (3) the rate of weight gain in the first ten days, and (4) the temperature curve and the pulse and respiration rates for the first ten days in eight hundred consecutive infants. The mother had been given either (*a*) paraldehyde alone per rectum or with morphine sulphate (five hundred cases) (*b*) rectal ether according to Gwathmey's technique (McCormick's modification) (one hundred cases), nembutal and scopolamine (one hundred cases) and there were one hundred controls. They concluded that obstetric analgesia, properly administered, does not increase the infant mortality or morbidity rate. In the paraldehyde group the interval between birth and the first respiration was measured by a stop watch and compared with the corresponding interval in one hundred infants whose mothers had received no analgesic or anæsthetic. The average interval in the two groups was 39·5 and 9·8 seconds respectively. The onset of respiration was therefore slightly delayed.

Cole *et al.* (1939) analysed five thousand deliveries with the object of finding the incidence and causes of asphyxia in the infant. They found that prematurity was the most important single factor in causing severe asphyxia, the incidence of which was also much higher in the infants of women over forty. The next most important factor was the trauma of labour. In infants of women who had no sedatives severe asphyxia occurred in

3 per cent. The administration of morphine within four hours of delivery was followed by severe asphyxia in 34·6 per cent.; if more than four hours elapsed between its administration and delivery the incidence was 17·7 per cent. With scopolamine the incidence of severe asphyxia increased with the amount given, but even with 1 unit (1/150 grains) it was somewhat increased, (*i.e.*, 4·8 per cent.), while after 5 to 9 units it was 10·2 per cent. After 6 or more grains of nembutal the incidence of severe asphyxia was 14·7 per cent.; after paraldehyde 26 per cent.; after nitrous oxide 14·2 per cent.; after ether anæsthesia of less than ¼ hour it was 6 per cent.; over one hour 12 per cent. They concluded that sedatives in any amount and general anæsthetics definitely increase the incidence of asphyxia in the baby in proportion to the amount given.

Pethidine (Demerol). It is claimed that this recently introduced analgesic does not cause any apnœa but no detailed observations such as those mentioned above have yet been published.

After consideration of all the evidence regarding the effect of analgesia and anæsthetics on the child it would seem that the following conclusions are justified.

(1) There is no ideal analgesic or anæsthetic for use in childbirth. All tend to cause apnœa in the infant but in varying degree.

(2) The most lethal analgesic agent is morphine which should never, if given at all, be administered less than four hours from delivery. It should never be given in premature labour or before Cæsarean section.

(3) The other analgesics in common use such as nembutal, scopolamine, paraldehyde, nitrous oxide and oxygen, etc., may be used with safety provided they are given in moderate amounts.

(4) The same is true of the anæsthetics ether, chloroform and cyclopropane. In their administration care should be taken that a clear air way is maintained and the patient not allowed to become deeply cyanosed.

(5) Pethidine may be less liable to cause apnœa than any other analgesic so far used but detailed observations have not yet been published.

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CHAPTER II

FUNCTIONAL DEVELOPMENT OF THE FŒTUS

THE mammalian fœtus[1] develops from a fertilized ovum as the result of successive cell divisions. The ovum is of a size so small that it can maintain itself, like the amœba, by the acquisition of such material substances as can be absorbed through its surface. It implants itself on the inner surface of the uterus and there proceeds to divide. In time it attains a size so large as to be

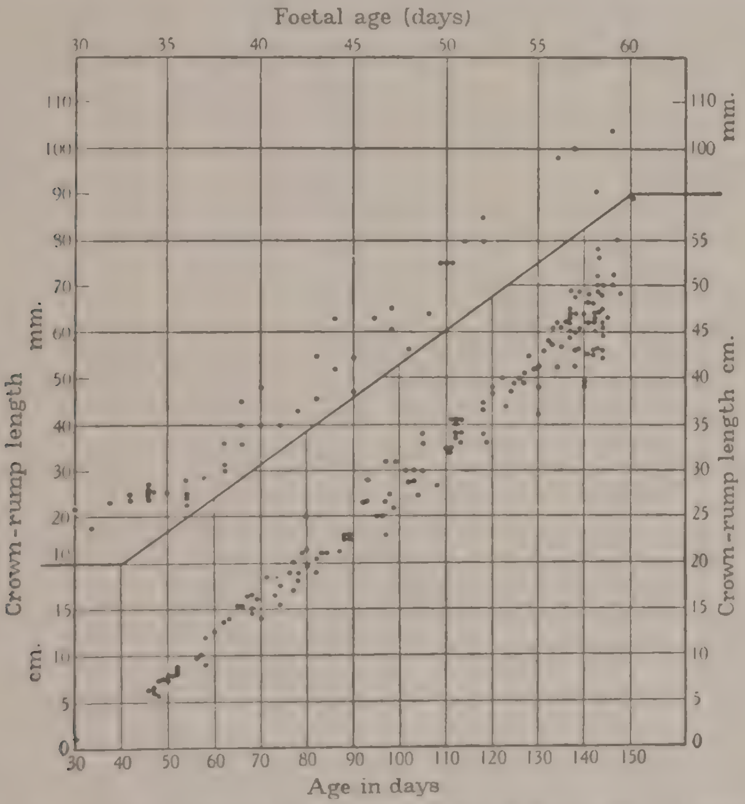

FIG. 7. Relation of fœtal age to crown-rump length (sheep). Gestation period, 147 days. (From Barcroft, J., 1946. 'Researches on Pre-natal Life.' Blackwell Scientific Publications.)

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[1] The word 'fœtus' is used in this chapter to denote the organism, whatever be its size, during its prenatal existence.

incapable of subsistence on the basis of materials which diffuse through its surface. It can only then be nourished by some definite system of irrigation. This system is, of course, the circulatory system and consists essentially of the heart and the blood vessels.

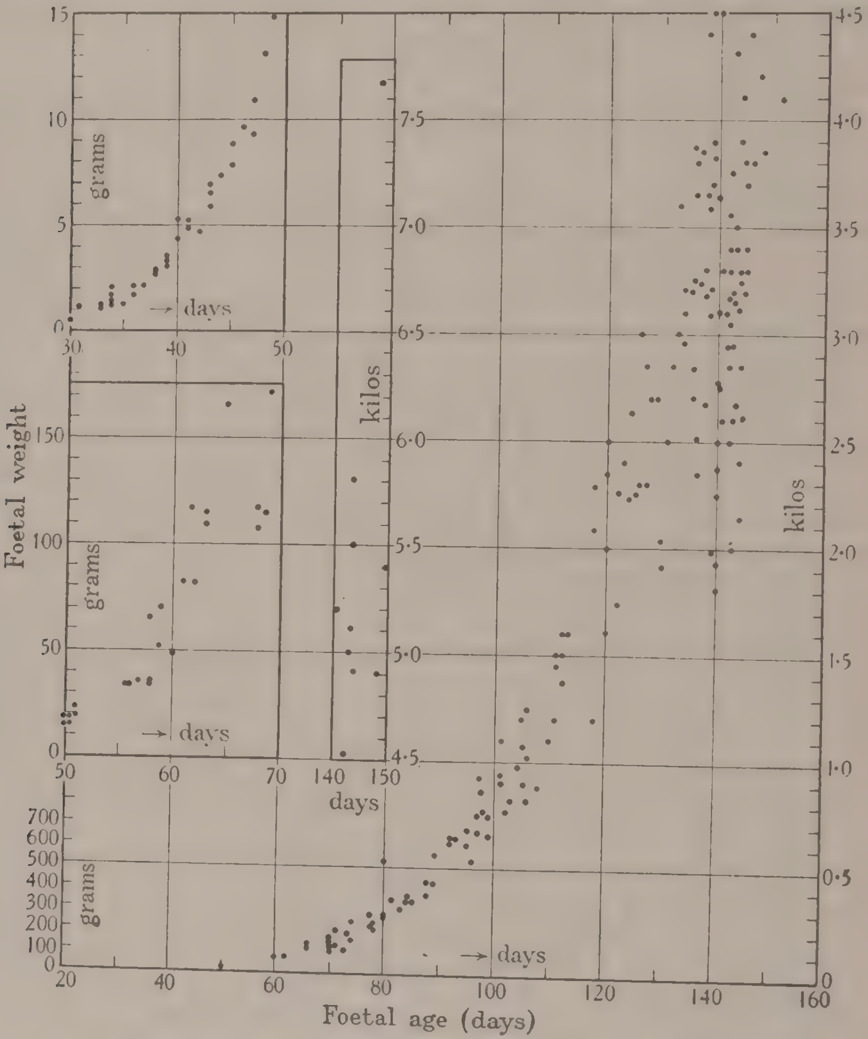

FIG. 8. Relation of fœtal age to weight (sheep). (*J. Physiol.*, 1946, 104, 32 P.)

Before discussing the functional development of the various systems, something must be said about the growth of the fœtus as a whole. So far as the human fœtus is concerned, tables will be found in the standard text books giving the principal measurements of the fœtus during gestation.[1] Figures 7 and 8 show the results of observations on the offspring of Welsh ewes (period of gestation one hundred and forty-seven days). Certain points are obvious.

(1) The scatter of points at any particular age is much less in the age-length curve than in the age-weight curve. It is therefore much more easy to tell the fœtal age from the crown-rump length than from the weight. It seems to be a pity that the measurement of the crown-rump length in some standardized way is not more commonly practised in maternity hospitals.

(2) That the scatter in the points for a given age should be greater in the case of the age-weight curve than in the age-length curve is inevitable, if only because the weight represents the cube of the linear proportions. Nevertheless the disparity is much greater than can be accounted for in this way. It is perhaps relevant to observe that the growth in length is the growth of a single tissue, bone, and of tissues the growth of bone seems to depend less on nutritional conditions than does the growth of the soft parts. In short, the length of the fœtus at a given age (in the sheep) is relatively standardized and for a given length there may, even in intra-uterine life, be plump and lean fœtuses.

(3) In both the age-length and the age-weight curves, but especially in the latter, the scatter becomes much greater as the end of the gestation period approaches. The age-weight chart (fig. 8) in fact gives the impression that in some individuals the fœtus continued to grow at an unimpaired rate up to the day of birth, whilst in others growth stopped at about one hundred and twenty days. The smallest fœtus shown at term is no bigger than the smallest at one hundred and twenty days. Here again the question of nutrition is raised. Did these small fœtuses stop growing

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[1] Hamilton, Boyd and Mossman (1945) give the following measurements of the human fœtus :—

Age (in lunar months)	Crown-rump length, *i.e.*, sitting height. mm.	Total length, *i.e.*, standing height. mm.	Weight. g.
3	55	70	20
4	100	150	120
5	150	228	300
6	200	300	635
7	230	350	1,220
8	265	400	1,700
9	300	455	2,240
10	335	500	3,250
	(*i.e.*, approx. 13 in.)	(*i.e.*, approx. 20 in.)	(*i.e.*, approx. 7 lb.)

for want of some nutritive factor, which for one reason or another they were denied?

The above considerations raise the question: is it possible to affect the size of the fœtus by restricting its diet? Wallace (1946) has proved beyond all question that this can be done in sheep. From a flock of a hundred ewes of the same breed a careful selection was made so that those chosen for experiment might be uniform in size. The selected ewes were fed on an ample diet for the first twenty-eight days of the gestation period. They were then divided into two batches A and B. Batch A was continued on the high level diet till the ninetieth day, whilst batch B was put on to a diet of substantially the same foodstuffs, but so meagre in quantity that though pregnant the ewes put on no weight. At the ninetieth day batches A and B were each divided into three batches, batch A into batch Aa and Ab and Ac. batch B into Ba and Bb and Bc. Batches Aa and Ba were fed on the high level diet, whilst batches Ab and Bb were fed on the low level diet. Ac and Bc were killed at ninety days.

The upshot of this experiment was as follows:

(1) Up to ninety days it made little difference to the weight of the fœtuses whether the mothers were fed on a high level or on a low level diet.

(2) At one hundred and forty-four days (*i.e.*, approaching term) the fœtuses in batches Aa and Ba differed little from one another in weight (always remembering that singlets must be compared with singlets and twins with twins). Similarly batches Ab and Bb differed little from one another.

(3) Fœtuses in batches Aa and Ba were on the average about half as heavy again as those in Ab and Bb.

In other words, it mattered little what the ewes were fed on during the first two-thirds or so of pregnancy, but during the last third the adequacy of the diet was all important. Satisfactory information about the effect of the mother's diet on the growth of the fœtus is much more difficult to obtain in the case of human beings than in that of sheep.

The surveys carried out at Toronto (Ebbs *et al.*, 1941, 1942), seemed to show that the income group of the mother and her consequent diet appeared to make little difference to the weight of the baby at birth, supporting the view rather frequently held that the fœtus is, in words which I have heard fall from the lips of a distinguished paediatrician, 'just a tumour,' and will run its mother down to any extent rather than be prejudiced itself. On the other hand, an extensive and painstaking survey carried out by Baird (1945) in Aberdeen, showed that the average weight of babies at birth in the low income level was smaller than in the high. Baird's figures, however, deal with the weight at birth and do not differentiate between light fœtuses born at the normal gestation period, and prematures which may have been of normal weight for the age. From the sociological standpoint it may not matter whether undernourishment causes the baby to be of deficient weight though born at the normal time, or of normal weight though thrust into the world prematurely; not so, however, when viewed from the angle of fœtal growth. Much greater deprivation of food took place on the continent of Europe in recent years than anything to which the women of low income groups either in Toronto or Aberdeen were subjected, and it may be hoped that out of the many observations which will be forthcoming, reliable information may appear. Meanwhile, Dr. Clement Smith of the Harvard Medical School has given the present author a preliminary note for publication (Barcroft, 1946), on observations which his group have collected in Holland. In this the effort has been made to separate the premature from the babies born at the normal term. Up to date, the findings of Smith (1947) agree with Wallace's, namely, that if the mother is starved at the latter end of pregnancy, the baby is small, but so long as she is well at the latter end, though starved earlier on, the baby does not suffer in size.

Water Content. Hitherto in considering growth rate we have considered that of the body as a whole and not the growth rate of individual constituents of the body. Of these constituents by far the heaviest is water. On the whole, the percentage of water in the body decreases as the fœtus develops, or to put it another

TABLE 2

Percentage of Dry Matter in Fœtal Tissues at Different Ages

Serial number .	620 622	631	651	644	657	658 662	652 658
Fœtal age in days	78	99	112	130	144	Lamb 6 days	Adult
Skin . .	10·6	12·0	14·5	24·2	21·7	22·3	29·6
Muscle . .	10·1	11·2	14·2	17·8	19·0	20·7	26·6
Cartilage . .	20·1	21·0	22·0	20·0	22·6	21·6	34·7
Bone . .	—	48·0	45·0	46·0	45·0	56·0	67·0
Liver . .	17·4	19·3	19·1	21·0	26·0	23·0	30·0
Gut . . .	—	14·0	14·6	(S) 15·1	14·0	17·1	18·5
				(I) 15·1	14·0	17·1	22·3
Lung . .	11·6	11·0	11·0	14·4	14·5	21·5	21·5
Kidney . .	11·9						
Blood . .	—	—	15·6	16·6	19	21·1	19·7
Brain . .	—	9·5	10·4	13·2	15·6	15·2	24·3

way, the percentage of solids increases. This, however, is not true of all tissue. The above (table 2), the result of observations made by Carlyle (1946), shows the percentage of water in the tissues of the sheep fœtus at various ages.

It seems an interesting phenomenon that a nervous system which is over 90 per cent. water, can do most things, short of thinking.

Circulatory System

The Heart Beat. Out of the work of Sabin (1920) grew the beautiful researches of Johnstone (1925) and Goss (1938) respectively, which showed that the initiation of the heart beat took place in that part of the primitive heart which ultimately became the ventricle (not the auricle or the sinus) and that it commenced as a series of rhythmical contractions which did nothing to propel the fluid.

The Pulse. Fundamentally the pulse rate increases as gestation proceeds and ultimately reaches a maximal rate at which it remains fairly constant. The following results (table 3) have been obtained by Bogue (1933), on the chick embryo within the shell from which electrocardiograms can be taken without impairment of the organism.

TABLE 3

Relation of Pulse Rate to Age in Chick Embryo

Duration of incubation in days	1 2	2–3	3–4	6–7	10–11	15–16	18–19
Number of embryos observed	11	10	6	6	6	6	7
Average pulse rate per minute	149	173	197	223	236	240	238

Similar results have been obtained by Cohn (1925) on the chick. Clark (1932) is satisfied that there is no vagus tone in the pulse of the cat, whilst Bauer (1938) takes the same view about the rabbit.

It is interesting to compare the above findings with the condition found in an animal born in a much more highly developed state, *e.g.*, the sheep. In the sheep fœtus when both vagi are cut, the curve of pulse rate plotted against age is similar in shape to that obtained in chick, but in the sheep fœtus *in utero* the shape of the curve is other. The difference commences at about eighty to one hundred days, at which point the pulse commences to get slower and becomes increasingly slow as development proceeds, indicating a growing degree of vagus control. The point is illustrated by fig. 9.

The question arises: is there any degree of vagus control in the human fœtus? The answer is as yet uncertain, but in as much as observations carried out by Dr. James Young and Dr. Kenny (1946) at the British Post-graduate Medical School indicate in some fœtuses a slowing of the pulse towards the end of pregnancy, there is some ground for supposing that a limited degree of vagus tone may exist. That the machinery for nervous control exists is clear from the reactions of the heart, during exertion (crying) and sleep; the question at issue is—is this machinery in use during fœtal life? (fig. 10).

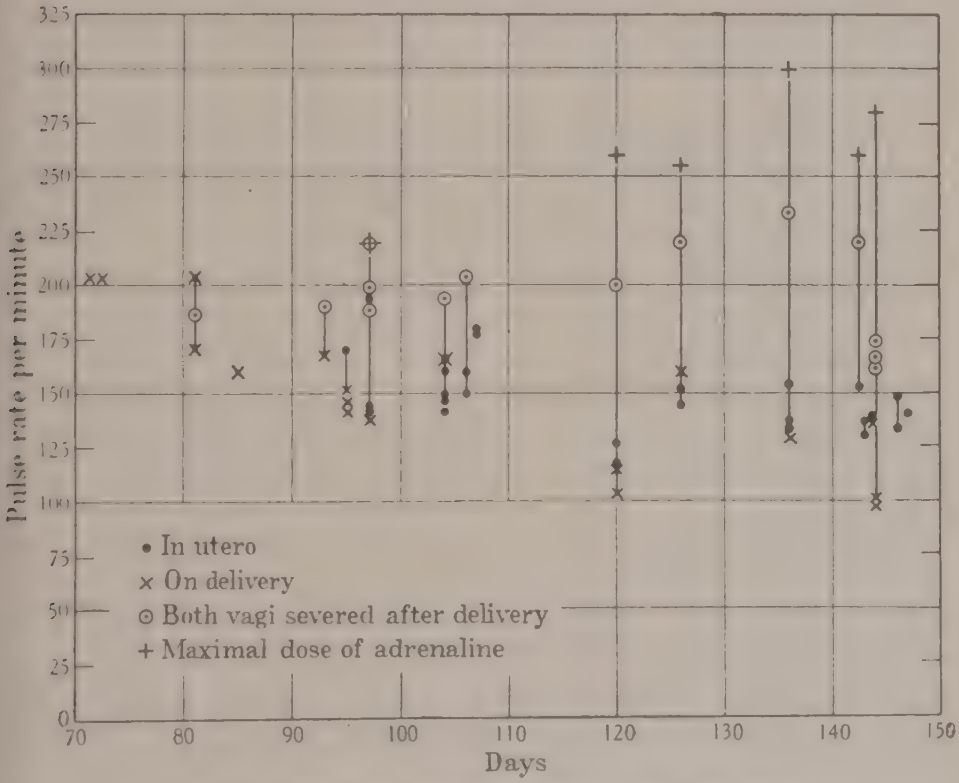

FIG. 9. Pulse rate considered in respect of fœtal age. (*J. exper. Biol.*, 1945, 22, 66.)

The Output of the Fœtal Heart. The most reliable method of measuring the output of the fœtal heart is by direct cardiometry. This method, largely due to the skill of Professor Torrens, has been brought to a much higher degree of accuracy than formerly. The information at present available from the fœtus of the sheep

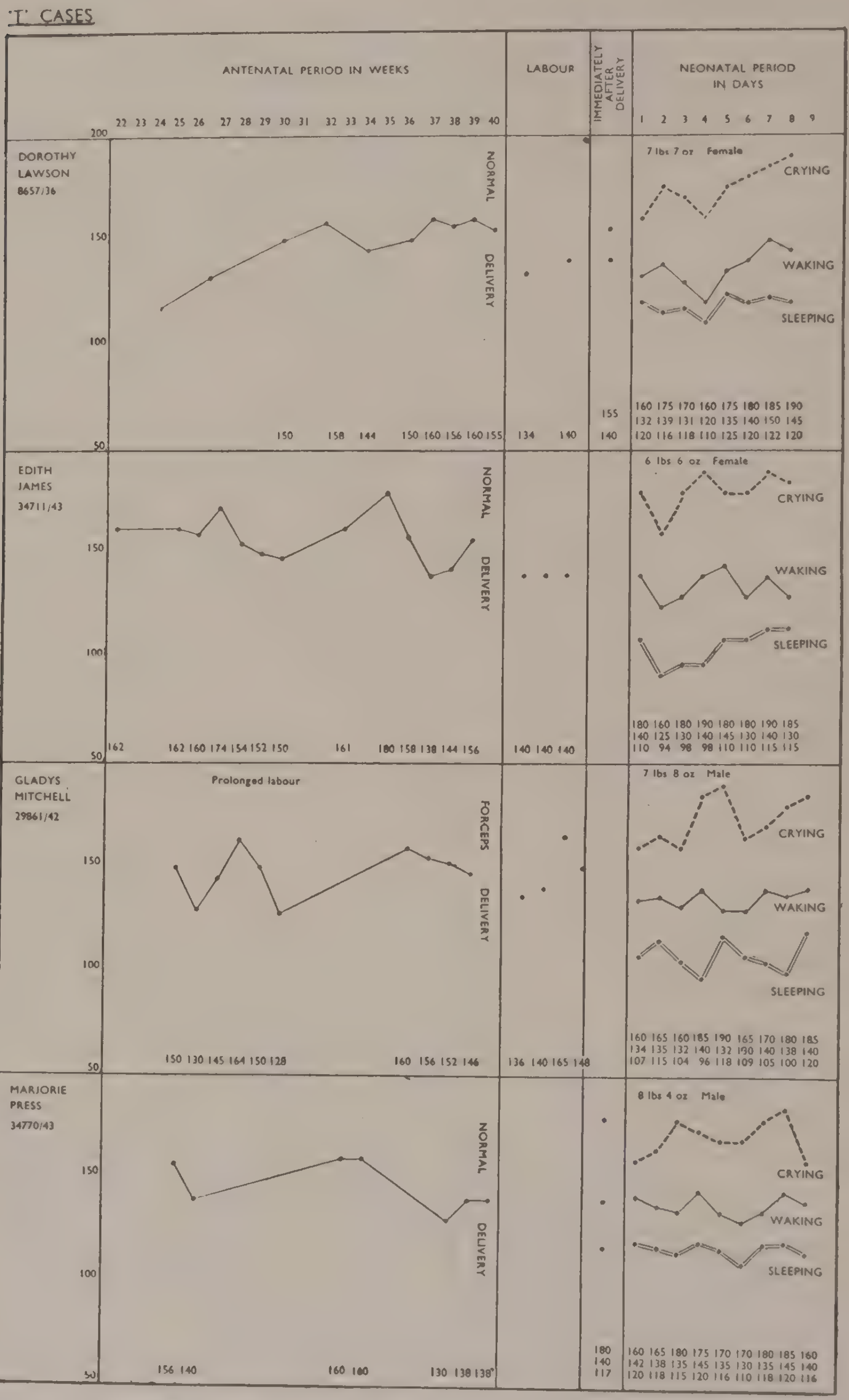

FIG. 10. Average pulse rate of children observed by Young and Kenny life, crying, awake and placid, asleep. (From Barcroft, J., 1946.

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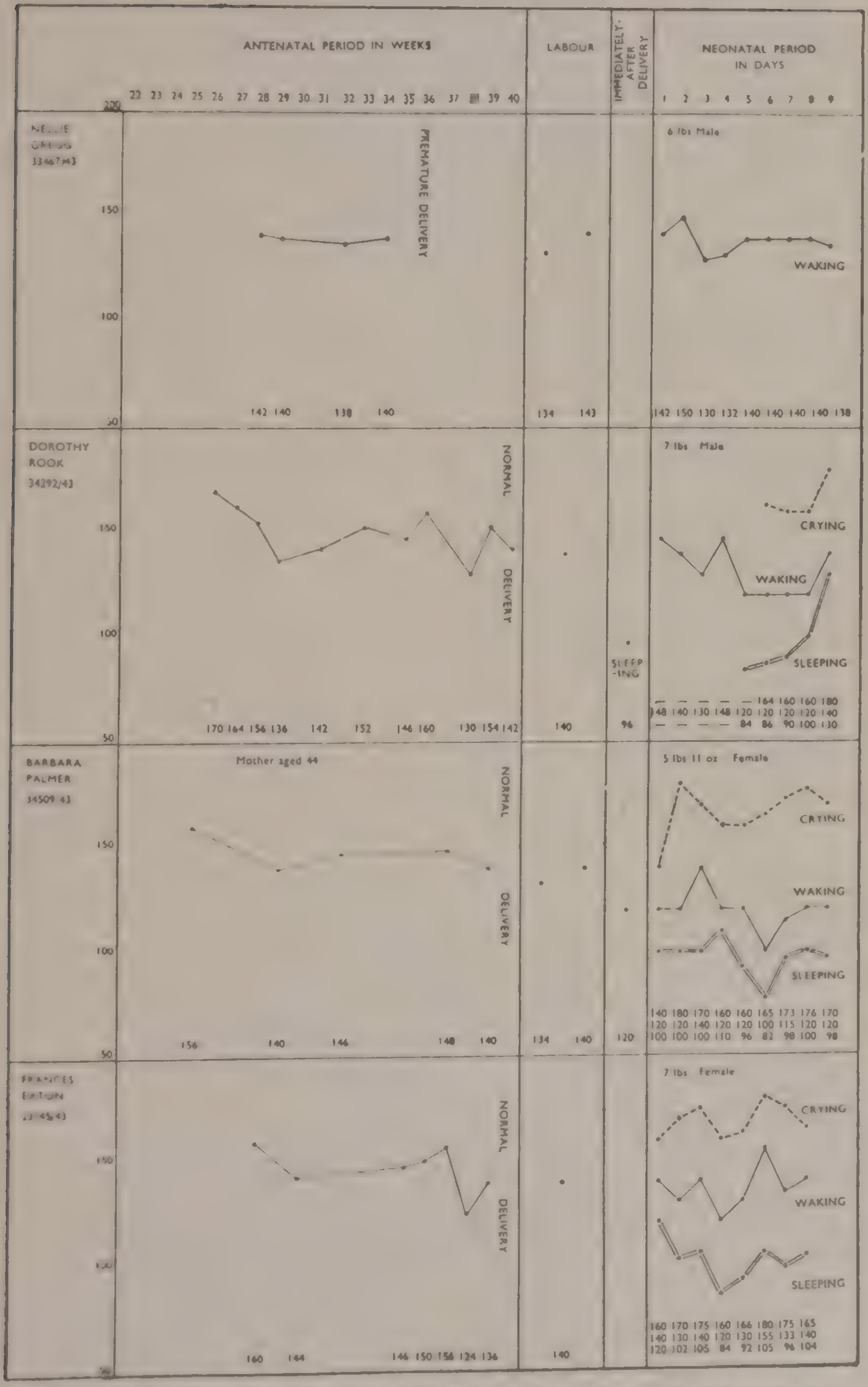

during the latter part of prenatal life and the first seven days of postnatal 'Researches on Pre-natal Life.' Blackwell Scientific Publications.)

only covers the last third of pregnancy; during this time the output of the heart naturally rises but the output per kilo of fœtus falls. At ninety-five days the volume of blood being delivered by the ventricle of the heart is as much as 400 c.c. per kilo of fœtus. At one hundred and thirty-six days it is about 280 c.c. These volumes are much greater than in the adult relative to the size of the organism. A man doing heavy, but not exhausting work, passes about 240 c.c. per kilo per minute through his ventricles (not each ventricle), whilst 400 c.c. is probably near the limit of which a man would be capable under the most extreme circumstances (Barcroft and Torrens, 1946). The statement that the output of the heart rises as the fœtus gets older needs some qualification. It may not hold true for the very last weeks of pregnancy. It is possible that the maximal output may be about a fortnight or three weeks before term. The point is not as yet decided (Barcroft, Kennedy and Mason, 1939).

The Blood Flow Through the Placenta. This relatively enormous burden placed upon the fœtal heart is in part the price exacted by a system of respiratory exchange so inefficient as that of the placenta. The basal metabolism of the fœtus (in terms of oxygen uptake per kilo of body weight) seems to be not very different from that of the adult—a point which will be taken up later—but whereas each litre of blood passing through the lung takes up, say, 80 c.c. of oxygen, the same quantity of blood passing through the placenta takes up about 30 c.c., hence the relatively greater blood flow. The blood flow through the lung is necessarily half the total volume which passes through the heart in the same time, and the proportion of the blood traversing the placenta to that which traverses the fœtal heart seems to be at least as great. Measurements of as much as 60 per cent. have been made, but 50 per cent. may be taken as a normal figure (Barcroft and Torrens, 1946).

The Distribution of the Blood Flow in the Body. The outputs of the right and left sides of the heart seem to be approximately equal. The sizes of the ventricles are about the same and the pressure against which they severally expel the blood is about the same (Pohlman, 1909; Hamilton, Woodbury and Woods, 1937). What then happens to this blood? Recent combined work, in which Barclay, Barcroft, Barron, Franklin and Prichard participated, is fully discussed in 'The Fœtal Circulation,' by Barclay, Franklin and Prichard (1944), and seems to have settled for the time being certain points about the course taken by the fœtal blood.

(1) All the blood which reaches the heart along the superior vena cava goes *via* right auricle right ventricle to the pulmonary trunk.

(2) About three-quarters of the blood reaching the heart from the inferior vena cava finds its way directly to the left auricle and so through the left ventricle, and one-quarter into the right side of the heart and so to the pulmonary trunk.

Thus, if we consider 6 c.c. of blood leaving the heart, 3 c.c. will have come from the right side and 3 c.c. from the left. Of the 3 c.c. from the right side 1 c.c. will have reached that side from the inferior vena cava and 2 c.c. from the superior vena cava. The 3 c.c. of blood from the left side will all have come from the inferior vena cava. Clearly the amount of blood which goes to the head (in which I include all that part of the body supplied by the aortic arch) must be the same as that which comes from it, namely, 2 c.c. Therefore of the 3 c.c. which leave the left side of the heart, 2 c.c. go to the head and 1 c.c. joins the blood thrust into the dorsal aorta through the ductus arteriosus. Of the 6 c.c. which leave the heart, 2 c.c. go to the head and 4 c.c. down the dorsal aorta; of these four, 3 c.c. go to the placenta and 1 c.c. to the body. This calculation is of the crudest possible character and ignores vascular areas through which the blood flow is relatively small, though not absolutely so, such as the azygos vein and the lungs. In so far as the calculation is correct, the moral is that the blood through the hinder part of the body relatively to the weight of that part is very much smaller than that through the part supplied by the aortic arch (by the aortic arch is meant that part of the aorta between the aortic valves and the entry of the ductus arteriosus). It should be remembered that the fore part of the organism includes the heart, the brain and the large glands in the neck.

The liver occupies a special position, because its principal blood supply is not directly from either right or left side of the heart but from the umbilical vein (Barclay, Franklin and Prichard, 1944).

Blood Pressure. I have compared the volume of blood passing through the fœtal and adult hearts. Stressing the magnitude of the former, the work done by the fœtal heart is not so disproportionately great, because the fœtal blood pressure is much lower than the maternal. Observers (Ribemont, 1879; Seitz, 1901; Cohnstein and Zuntz, 1884; Schlossmann, 1932; Clark, 1932; Hamilton, Woodbury and Woods, 1937; Haselhorst, 1929) have differed in their estimates of arterial blood pressure in the fœtus, giving figures which range from 21 to 110 mm. In the sheep (at birth the lamb of a Welsh ewe is roughly the same size as a baby) the fœtal arterial pressure rises gradually from under 10 mm. at

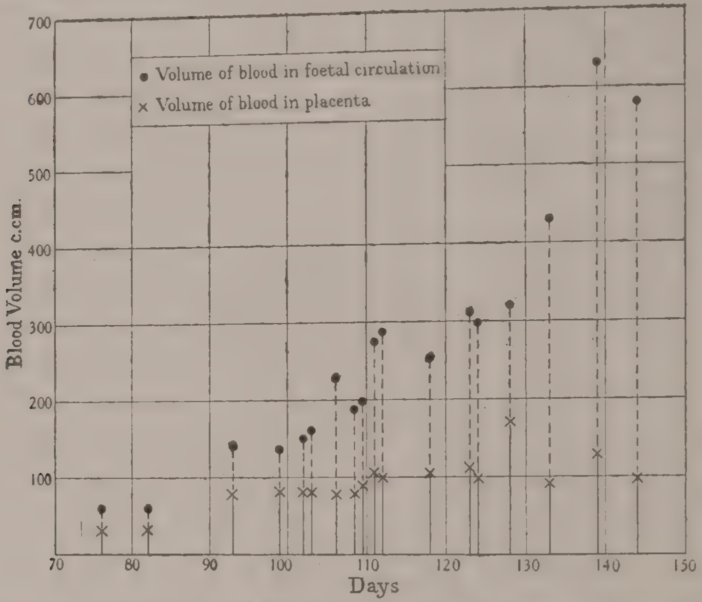

FIG. 11. Distribution of blood in fœtus and placental cotyledons respectively. (*Lancet*, 1941, *ii*, 91.)

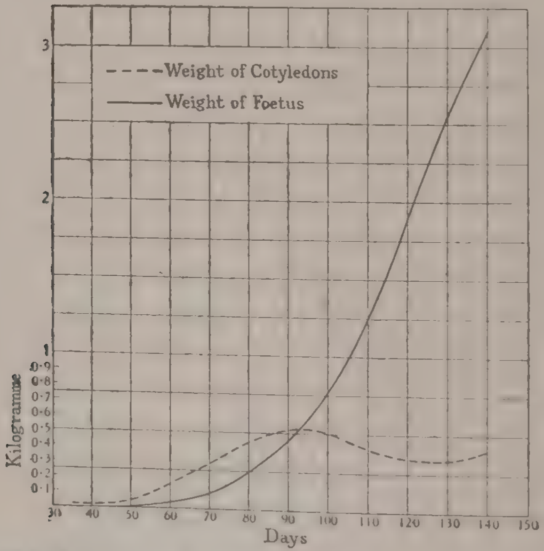

FIG. 12. Weight of placenta in relation to fœtal age. (*Lancet*, 1941, *ii*, 91.

forty days to about 50 mm. at term. During and after birth rises considerably so that the blood pressure of the newbor lamb may be 80 mm. The principal causes of difference between different observers are: (*a*) that their observations were made on forms born in very different states of development, and (*b*) that the manipulations employed in making the observations produced alterations in the vasomotor systems of animals in which those systems were developed prenatally, comparable with those which occur during birth.

The pressure in the umbilical veins undergoes small fluctuations, and indeed late in pregnancy, rhythmic fluctuations, but the mean is about 10 mm., rising perhaps a little at the end of the gestation period. Thus there is an ever-widening disparity between the pressure in the umbilical artery and that in the umbilical vein, the difference at sixty days being about 15 mm. and at term about 40 mm. This difference of pressure, which is responsible for the flow of blood through the placenta is considerably greater than that between the pressure in the pulmonary artery and pulmonary vein respectively.

Blood Volume. Elliot, Hall and Huggett (1934), working on the goat, estimated the weight of blood in the fœtal circulation as being one-tenth of the combined weights of the fœtus and placenta. Though perhaps a slight under-estimate and open to some criticism in detail, further research has proved it to be, in principle, true.

The blood volume presents two points of interest :—

(*a*) The distribution of the blood between the placenta and the fœtus respectively. This is shown in fig. 11; alongside it are shown the relative weights of the fœtus and placenta during gestation, fig. 12. The comparison will show the correctness in principle of Elliott, Hall and Huggett's point of view.

(*b*) In the sheep about 40 c.c. of blood per kilo, or 120 c.c. for a lamb just under 7 lb., seems to be added by the placenta at birth to the quantity of blood already in the vessels of the fœtus proper (Barcroft and Gotsev, 1937). For man, Marsh, Windle and Alt (1939) give the following figures for babies :—

TABLE 4

Blood Volume of Newborn Infant in c.c. per kilo

	Lowest	Medium	Highest
Cord tied early	70–75	90–95	125–130
Cord tied late	80–85	100–105	145–150
Difference per cent. . . .	13	11	14

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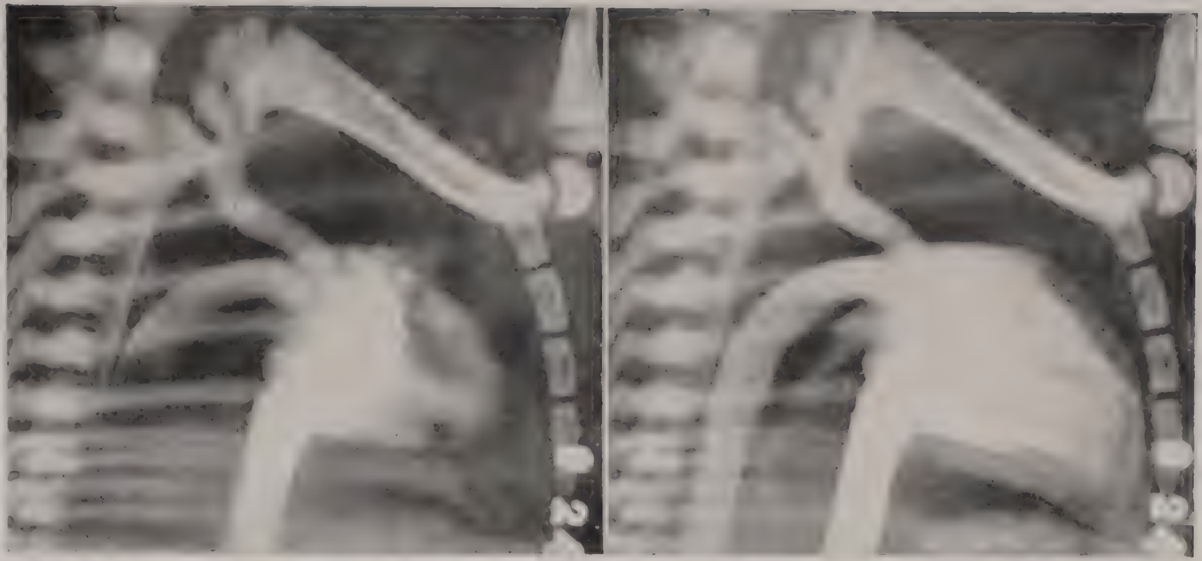
The merit or otherwise of allowing this blood to go into the circulation of the newborn babe is a matter for discussion. On the one hand the baby, in its new environment, is capable of much more activity and more sustained activity than is the fœtus and might be expected to require more blood to meet the emergency; on the other hand, the conditions of anoxia under which the fœtus exists late in pregnancy dictate for it, as for the dweller in high altitudes, an amount of hæmoglobin which is unnecessary for an organism which breathes air. Actually in the sheep about half the hæmoglobin thrust into the fœtus at birth disappears from the blood of the lamb in the first week or two. It is reputed to be stored in the liver to meet future requirements. These requirements are doubtless much greater in the infant.

Fœtal Respiration. The primitive arrangement of vessels in the placenta consists of parallel loops, fœtal and maternal. Each loop consists of a central artery which runs to the end of the loop and a system of capillaries along which the blood returns. Thus the capillary systems of the fœtal and maternal circulation run side by side in close proximity the one to the other, but the streams run in opposite directions. In some species, such as the sheep, that arrangement persists; in others, such as man, the maternal circulation is reduced to a system of sinuses, but the general arrangement of the streams of blood persists. Thus the poorly oxidized fœtal blood arriving *viâ* the umbilical artery finds itself in juxtaposition to the poorly, but less poorly, oxygenated vein and the richly oxygenated fœtal blood leaving the placenta along the umbilical vein is in juxtaposition to an even more richly oxygenated maternal blood arriving at the placenta *viâ* the uterine artery (Hamilton, Boyd and Mossman, 1945). Thus a system exists, along the whole course of which oxygen can keep diffusing from the maternal to the fœtal vessels and conversely CO_2 from the fœtal to the maternal without the establishment of an equilibrium.

Considering that the fœtal blood only acquires its oxygen at second hand, that which emerges from the placenta is often surprisingly red. The cause of this redness, or in other words, of its high oxygen saturation, is to be found in the fact that the hæmoglobin of the fœtus is different from that of the mother. The fœtal hæmoglobin has a greater affinity for oxygen than the maternal.

Over a great part of fœtal life in the sheep, the blood which reaches it is perhaps 75 to 80 per cent. saturated. This blood, after some intermixture with blood from the body, reaches the heart; and what next? The course of the streams of blood



13A. 13B.

FIG. 13. Sheep fœtus (135/147 days). Nose-bag on—cord divided. Contrast material injected into one of the umbilical veins within the cord is seen passing up the thoracic posterior vena cava to the heart. Note in (*a*) the prompt appearance of a good shadow in the ascending aorta, brachiocephalic artery and aortic arch, indicating a considerable flow through the 'foramen ovale' and left heart; in (*b*) one second after (*a*) the later appearance of a less pronounced shadow in the pulmonary arteries and ductus arteriosus, indicating a much smaller flow through the right heart. (From Barclay, A. E., Franklin, K. J., and Prichard, M. M. L., 1944. 'The Fœtal Circulation.' Blackwell Scientific Publications.)

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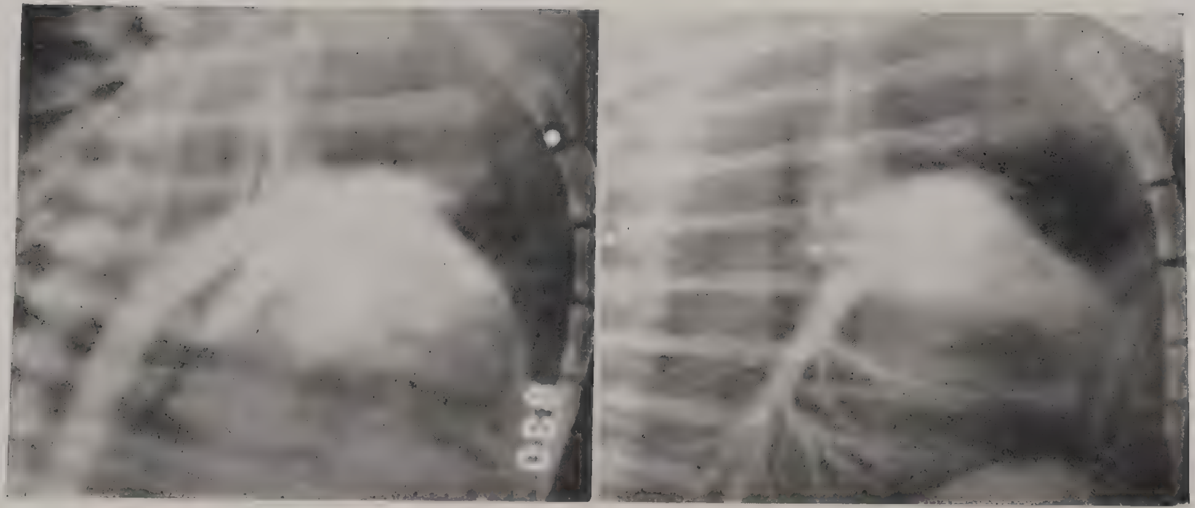

14A.

14B.

FIG. 14. Sheep fœtus (144/147 days). (*a*) Anterior caval injections six and a half minutes after delivery but just before ligation of umbilical cord. The contrast medium is passing freely through the ductus arteriosus to the descending aorta as well as the pulmonary arteries. (*b*) Another caval injection four and a half minutes later. The nose-bag has been removed and the cord divided four minutes before this injection. The contrast medium is now passing to the pulmonary arteries only, no shadow is seen in the descending aorta, *i.e.*, the ductus arteriosus is functionally closed. (From Barclay, A. E., Franklin, K. J., and Prichard, M. M. L., 1944. 'The Fœtal Circulation.' Blackwell Scientific Publications.)

reaching the heart has been the source of much controversy. The question has been re-explored by means of the X-ray cinematograph (for the literature of which see Barclay, Franklin and Prichard, 1944) and by plethysmograph methods. The following facts seem to be established :

(1) Blood arriving along the umbilical vein may take one of two paths : (*a*) through the ductus venosus, (*b*) through the vessels of the liver. In either case it meets and unites with the flow arriving along the portal and hepatic veins before the blood in these streams collectively form that in the inferior vena cava.

(2) Towards the later part of pregnancy there seems some reason to suppose that the streams of venous blood coming from the body constitute a larger proportion of the mixture in the inferior vena cava than they do in the earlier stages of pregnancy.

(3) The inferior caval flow on reaching the heart impinges upon a sort of knife edge—the ' crista dividens '—which diverts about three-quarters of the stream through the foramen ovale. The valve of the foramen ovale really combines with the wall of the septum to form a tube through which the blood flows into the left ventricle.

(4) The remaining quarter is diverted into the right auricle where it meets and mixes with the superior caval flow.

(5) The superior caval flow is about half the volume of the inferior caval flow. It goes entirely into the right heart and through the ductus to the descending aorta and pulmonary arteries (fig. 14*a*).

(6) Thus of every 6 c.c. of blood reaching the heart 4 c.c. come from the inferior and 2 c.c. from the superior caval flows respectively. Three, all inferior caval, go to the left side of the heart, and 3 c.c.—1 c.c. inferior caval and 2 c.c. superior caval—go to the right side. Each ventricle then receives and discharges 3 of the 6 c.c.

(7) Of the 3 c.c. which are discharged into the ascending aorta 2 c.c. go to the head, neck and arms, and will after traversing the tissues form the superior flow ; the third traverses the isthmus of the aorta and so reaches the descending aorta.

(8) The 3 c.c. discharged from the right side pass along the ductus arteriosus (apart from a quantity going into the pulmonary vessels, which we may neglect), so to the descending aorta.

(9) Of the 4 c.c. which have arrived in the ascending aorta (1 c.c. from the isthmus and 3 c.c. from the ductus) 3 c.c. go to the placenta and so through the placental capillaries to the umbilical vein ; 1 c.c. goes to the lower part of the body.

Of course no such cut-and-dried scheme can be more than the merest approximation. The proportions probably differ as gestation proceeds and the scheme leaves out streams important in themselves but small relatively, *e.g.*, the coronary circulation, the pulmonary circulation and the azygos stream.

The physiological implication of this arrangement is that the brain, the coronary system and the head generally exercise a priority on the oxygen reaching the fœtus, whilst the organs in the lower part of the body, organs which during fœtal life have little functional significance, receive oxygen on a rather lower priority. At birth the ductus arteriosus closes within a few minutes of occlusion of the cord (fig. 14*b*) and the foramen ovale even before that.

Central Nervous System

The physiological development of the fœtal central nervous system as opposed to the anatomical, has been the object of relatively little research and of that little the greater part is tied up with the proof or disproof of particular theories as to be almost within sight of being tendentious. The theories in question arise from different approaches to the subject. One approach is from the angle of ' behaviour ' and is of particular interest to pædiatricians. Its starting point was the classical work of Coghill (1929) on the larval form Amblystoma, and is to be found in his book ' Anatomy and the Problem of Behaviour.' The essence of the theory was that the various complicated movements of which the mature animal is capable were segregated from a gross movement involving the whole body. To the extreme votaries of the theory movements are described in terms not of the actual parts which move but in terms of motives. They speak of a ' defence movement,' and so forth. The contrary school speak in purely objective terms and believe that the central nervous system develops segment by segment, that when in each segment a bridge has formed between the afferent and the efferent nerves, a reflex is forthcoming; further, when these reflexes are knitted together, more complicated movements eventuate. The arguments for this theory are set forth in Windle's book ' Physiology of the Fœtus ' (1940).

Avoiding theories, the following may be said :—

The central nervous system starts its development at the lower part of the medulla; the first reflex movements are obtained from stimulation of the fifth cranial nerve and take the form of contraction of some one or more of the neck muscles. The movement produced by this contraction is not the same in all animals: it may be a raising of the shoulder, but most frequently is a turning of the head. This phase appears in the sheep fœtus at about thirty-four days. In the sheep stimulation of no other afferent nerve produces an effect for some days but by that time the response from the fifth nerve has spread to the whole body and becomes rhythmic, the fœtus responding by perhaps a dozen or twenty spasms; each spasm involves most of the head, the trunk, the diaphragm and the limbs. In each spasm the movement is in the nature of a twitch and the whole spasm resembles a gasp. It is possible to transect the brain at about sixty-six days without taking the fœtus from the uterus, or prejudicing the growth of the embryo. If such a transection is made just above the nucleus of the hypoglossal nerve, the fœtal movements (apart from those for which the third and fifth cranial nerves are responsible) are similar to those made by a fœtus of, say, thirty-nine days, individual jerky spasms involving most of the body. Hitherto only the lower part of the hind brain is involved.

At about the thirty-ninth day, sensory nerves other than the trigeminal commence to be operative; roughly speaking they do so, in time, from above downwards, with this disturbing circumstance, namely, the larger a nerve is the sooner it becomes operative. Thus, relatively to other nerves, those from the arms and legs are a little precocious. Each sensory nerve as it comes into the field at first has a local effect only; then the response spreads to a wider field and ultimately shrinks to something purely local.

In the days between forty-two and fifty quite a number of alterations take place. The typical response to sensory stimulation becomes more complicated. No longer is it a rhythm of spasms each resembling the one before it. The initial response is a sort of righting movement in which the limbs assume and maintain a definite posture. This passes off and is followed by an after discharge similar to the rhythm of spasms which was the feature of the forty-two day stage. The general appearance is that of the fœtus making a, for it, titanic effort, and being subsequently out of breath. At this stage the apparent respiratory rhythm, as I may now call it, is never independent of some muscular movement. This association between the somatic and respiratory movements is maintained so long as central mechanism involves nothing above the medulla. About the forty-sixth day, a feature of considerable interest occurs; if the fœtus is on its side, the initial writhe involves a turning of the neck in such a way as to present the crown of the head skywards, and this in turn causes the limbs to take up postures similar to those described by Magnus and de Kleijn. These movements do not seem to depend on the integrity of the semicircular canals; rather they seem to be a reaction to the unequal strain put by gravity upon the muscles of the neck and body. Once the pontine region is involved (probably the essential element is the eighth nucleus) respiratory movements become almost continuous and may take place without an obvious connection with somatic movement. The fœtus at this stage is extremely active. This stage commences about the fortieth day and is most manifest between the fiftieth and sixtieth day. After the sixtieth day the fœtus becomes much quieter. Indeed, were it not that a sleeping animal still breathes, the general appearance of the fœtus might be compared to that of a lamb in an uneasy sleep. This phase of inhibition involves the functional continuity of the inferior corpora quadrigemina with the parts below it.

From the time at which the movements ceased to be jerky becoming increasingly sustained, *i.e.* from about the forty-first or forty-second day, there is little change in their general character. By the sixty-eighth day a new feature appears; when in the inhibited animal movement is provoked by stimulation, that movement involves a degree of rigidity not hitherto seen.

There is little further to be said: decerebration seems to have no effect. The fœtal movements change little until birth takes place.

It is interesting to compare the prenatal mechanism as we have seen it to be built up, with that which operates in the mature animal. For purposes of this comparison, the conception which we have of the respiratory mechanism as it seems to be built up before birth depends upon the fact that the brain develops functionally, though not of course structurally, from below upwards.

(1) With only the lower part of the medulla developed the fœtus is capable of only a *gasp*.

(2) With a somewhat higher medullary development there appears the rhythm, the latter being always associated with muscular movements.

(3) When development of the eighth nucleus is complete, the respiratory rhythm becomes detached from somatic muscular movement.

(4) When development reaches the inferior corpora quadrigemina, an element of inhibition appears.

What then is the state of affairs in the adult? Till the year 1923 respiration was usually thought of as being governed by ‘the respiratory centre,’ the *noeud vital* of Flourens located in a smaller area near the tip of the calamus scriptorius. Admittedly many authors regarded it as a double centre, inspiratory and expiratory. Lumsden represented the central mechanism for respiration as something which from end to end stretched over a considerable portion of the brain stem and which could be divided into four main compartments from below upwards.

(1) A gasping centre situated on the lower part of the medulla.

(2) An expiratory centre situated somewhat below the striæ acousticæ.

(3) An apneustic centre at the level of the striæ.

(4) Pneumotaxic centre situated at the level of the upper part of the pons Varolii.

The gasping centre explains itself, the gasp being a rapid inspiration taking place enshrined in a much more extensive movement.

The expiratory centre also requires no explanation except to say that in the mammal it is of secondary importance to the inspiratory centre.

The apneustic centre when stimulated produces long maintained inspirations.

The pneumotaxic centre exhibits its activity as normal respiration.

Here then is the comparison :—

Table 5

	Fœtus (sheep).	Adult (Lumsden, cat)
Lower part of medulla	Gasp.	Gasp, inspiratory.
Below striæ accousticæ	Rhythm associated with movement of head and neck muscles.	Inspiration and expiration.
Above striæ accousticæ but below pons.	Rhythm detached from muscular movement.	Apneustic (a series of inspirations, without expiration).
Above posterior corpora quadrigemina and pons.	Inhibition so that greater sensory stimuli are necessary to produce respiration.	Pneumotaxic, *i.e.*, ordered respiration of a quiet kind.

We learn that the sites in the brain at which important additions are made to the respiratory mechanism are roughly the same for the fœtus and for the mother. The gasp is common to both ; when we get to centres above the lower part of the medulla, obvious differences appear. The effort to reconcile them would be fascinating, but without more knowledge unfruitful. But one starting point for such an effort is obvious, namely, that the fœtus is in a sensory vacuum, the mother is in a sensory field. To take a single instance, when the fœtus makes a respiratory movement there is no distension of the lungs and consequently no stretching of the vagus fibres therein. When the adult makes a respiratory movement a flood of sensory stimuli is let loose, which have a profound effect on respiration.

Having seen the mechanism of respiration gradually built up and then put by, it was with something like the thrill which attends the launch of a ship that I first witnessed it come into action. Professor Young afforded me the opportunity in the Unit at Hammersmith of witnessing ten successive births, my sole object being to observe the respiratory pattern, or patterns, which the babies exhibited on their entry into the world. Of these patterns I saw three distinct ones, together with some 'intermediates.' They were as follows :—

One fœtus commenced breathing with quite normal respirations. This respiratory rhythm commenced when the head only had emerged. It was unaccompanied by cyanosis.

Three fœtuses entered life with a gasp. That which gave the most typical gasp was intensely cyanosed.

The third pattern presented by those of intermediate cyanosis was neither a gasp on the one hand nor a regular rhythm on the other, but a deep long-drawn inspiration.

The baby, the blood of which was well oxygenated and which commenced life on exposure of the head and with a normal rhythm, would appear to have its brain working right up to and including the level of the pons Varolii.

The babies which commenced life with a gasp, and that after the lapse of a considerable time, probably only had the lower part of the medulla at their disposal. The function of all parts higher than the region of the nucleus was knocked out by the want of oxygen.

The babies which commenced to breathe with a long-drawn-out respiration presented a picture which I had not observed in the fœtus. It obviously represented some condition between that in which the whole of the brain stem, including the pons, was functioning and that in which only the lower part of the medulla was in action. At the time I interpreted the phenomenon as representing a condition in which the medulla was sufficiently sensitive for the impulses caused by the stretching of the lung to act as a drag on the gasp and convert it from something sudden to something which was stretched out over a considerable time. Whether in the light of more recent work, notably the beautiful experiments of Pitts, Magoun and Ranson (1939), that interpretation would need revision is a question which we must leave till a future occasion.

The babe before birth, then, has his machinery for respiration completely elaborated but held in a condition of inhibition; whether or not the baby breathes depends upon the degree to which that inhibition can be overcome by sensory stimuli (in which the flow along the fifth nerve probably plays an important part) or alternatively can be abolished by anoxia; in the latter case the baby gasps, in the former it breathes normally. The intermediate patterns probably depend upon intermediate degrees of sensory activity and impairment of function of the inhibitory mechanism.

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CHAPTER III

THE NEWBORN

The period during which an infant is regarded for statistical purposes as 'newborn' is the first month after birth, and deaths during the period are classified as neonatal deaths. Some authors, however, in considering the newborn, confine themselves to the first fourteen days of life or to the lying-in period of the mother.

Physical Status of the Newborn

Birth-weight. Since it is usually impossible to determine the exact date of conception, the birth-weight has been generally adopted as the criterion in deciding whether an infant is full-term or premature. Infants who weigh 5½ lb. (2,500 g.) or less at birth are classified as premature, irrespective of the period of gestation. Whilst this arbitrary standard is not scientifically accurate (for instance, full-term twins and more rarely other infants may weigh less than this amount), it has a practical value, since most infants under 5½ lb. will require special care. It is also generally true that the more the birthweight is below 5½ lb., the more precarious is the infant's hold on life.

The birth-weight is of little value in determining post-maturity since the weight-range of normal full-term infants is very considerable, and giant infants may be produced by incipient maternal diabetes and other causes. The birth-weight of the great majority of normal infants, however, falls between 6 and 8½ lb. (approximately 2,725 g. and 3,855 g.), with an average of approximately 7¼ lb. or 3,290 g.

Weight-loss. The newborn normally loses weight during the first two to five days, owing to the relatively small fluid and food intake during this time. Large infants tend to lose more than smaller ones, the weight-loss usually varying from 4 to 8 oz. (125 to 250 g.). The amount of weight lost can be reduced by forcing fluids during the first week, but there is no advantage in doing so unless the weight-loss is accompanied by a rise of temperature (so-called 'dehydration fever') or other evidence of dehydration, or is excessive. The birth-weight is normally regained by the seventh to tenth day, except in the case of infants who have lost more than 8 oz., when the recovery time is somewhat longer.

Length and Proportions. The average length of the infant at birth is approximately 20 in. (50·8 cm.); Bakwin and Bakwin (1934) have shown that first-born infants tend to have slightly smaller external dimensions than later-born infants, whilst girl infants are slightly smaller on the average than boys.

Reference to figs. 2 and 3 (Introduction) will show that the head of the newborn represents approximately one-quarter of the total length, whilst the leg-length is slightly less than three-eighths. The umbilicus lies slightly below the mid-point. (The newborn infant is seldom seen in the position shown, as it tends always to lie with the legs and arms flexed and the hands clenched).

Head. The average circumference of the head at birth is approximately 13·7 in. (34·8 cm.), the average for girls again being slightly less than that for boys, and some differences in mean value being observed in different groups examined.

Depending on the pressure exerted on the head during birth, the skull may show some degree of moulding and even some over-riding of the sutures; in the absence of intracranial damage, these changes leave no permanent effect. The presence of a *caput succedaneum*, or œdematous area over some part of the head which has presented during a prolonged labour, is often observed at birth, but disappears rapidly. A *cephalhæmatoma*, or large fluctuant swelling in the scalp area due to the presence of blood beneath the periosteum, is evidence of local trauma, but if uncomplicated is of no serious significance. It should be left alone and should not be aspirated, since absorption and calcification will occur spontaneously. Although the swelling is unsightly, and may later be palpable for some time as a calcified boss, it will be found that ultimately it gives rise to no appreciable cranial deformity. It should be remembered that calcification of these hæmatomata starts at the margin, and if one is palpated for the first time after calcification has begun but is incomplete, it may be mistaken for a depressed fracture.

The *anterior fontanelle* is readily palpable at birth, and varies greatly in size; it is normally pulsatile, but if it is found to be tense or bulging, intracranial hæmorrhage should be suspected. The sutures are often more easily palpable than in the older infant, and one or more of the five other fontanelles present at birth may often be identified clinically.

Chest. Although the thoracic cage is relatively soft and flexible during the newborn period, and the respiratory excursion is slight, it should be possible to detect inequality of movement or deformity of the ribs, *e.g.*, due to fracture.

Breast-enlargement, which may be bilateral or unilateral is commonly observed in both sexes during the newborn period. It is due to the presence of maternal œstrogens in the infant's circulation, and usually disappears spontaneously within two to three weeks. The secretion of 'Witches' milk' (Hexenmilch) which often accompanies the enlargement is due to prolactin, possibly also of maternal origin. No treatment is required, and the forcible expression of milk or attempts to 'break the nipple strings' are likely to lead to an inflammatory reaction (true mastitis neonatorum) or abscess formation.

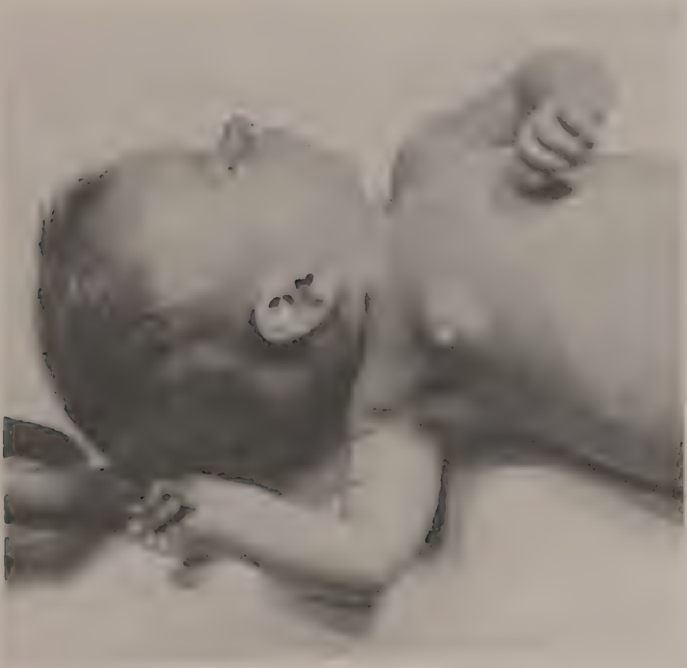

FIG. 15. Breast enlargement in the newborn, showing secretion of 'witches' milk.'

Abdomen. The abdomen appears relatively large in the newborn infant, and moves freely with respiration. The liver edge is normally palpable one or more fingerbreadths below the costal margin, but the spleen is not felt unless it is pathologically enlarged.

The umbilical cord rapidly becomes white or semi-translucent in colour after it has been tied (see below), and shrivels during the time that it remains attached. When the cord has separated, the umbilicus should be dry. Any stickiness or bleeding of the umbilicus is a danger signal, as it suggests the presence of sepsis, which may be of serious consequence.

Genitalia. In female infants, during the first or second week of life, there may be a transient swelling of the vulva associated with a whitish, mucoid discharge which is occasionally blood-stained. This is probably due to the presence of maternal œstrogenic substances in the infant. Both the swelling and discharge subside spontaneously during the newborn period. (When bleeding occurs, the condition must of course be distinguished from hæmorrhagic disease of the newborn.)

In male infants, swelling of the testicles or hyperplasia of the prostate is occasionally observed during the first week, but again this subsides spontaneously without treatment. The testicles should lie below the external abdominal ring at birth, though not necessarily completely within the scrotum. The prepuce is very commonly adherent to the glans and not fully retractile at birth ; it should be remembered that in a high proportion of cases it will become retractile later or at most require stretching. The circumcision of newborn infants is often recommended much too lightly. It should only be advocated on medical grounds in those cases where the prepuce is excessively long and where there is no prospect of its being retractile later, or where the orifice is so small as to interfere with micturition (shown by ballooning of the prepuce). Although the risk attached to the operation is slight, there is nevertheless always a possibility of hæmorrhage or sepsis, or the formation of a blister or crack at the meatus which causes pain on micturition, with frequent separation of the scab, whilst the cosmetic results of an inexpert circumcision are sometimes lamentable. In no case should the infant be circumcised during the first eight days, because of the physiological hypothrominæmia of that period, or when jaundice is present.

Skin. The skin of the infant at birth is usually erythematous and seldom shows appreciable jaundice. The pinkness tends to fade during the first few days, and during this time icteric tinting appears. The full-term infant is well supplied with subcutaneous fat, and the skin is elastic ; the nails extend slightly beyond the nail-beds ; lanugo is usually slight in amount, though there is a variable amount of soft, silky hair on the scalp, which tends to fall out during the first week. A wrinkled, inelastic skin at birth, the presence of much lanugo, and nails which are abnormally soft and do not extend beyond the nail-beds are indications of prematurity. Milia on the face are commonly seen, and small nævi on the frontal and occipital regions are so frequent as to be popularly known as ‘ marks of the stork’s beak.’

During the period of weight-loss, the subcutaneous fat will be reduced in amount, but seldom sufficiently to cause inelasticity of the skin. Where the loss is considerable, it is often followed by fine powdery desquamation.

Temperature. Regulation of temperature is poorly controlled by the young infant, who is far more dependent on the temperature and humidity of the environment than is the older child. It is relatively easy to produce a rise of temperature to 100° F. (38° C.) or fall to 97° F. (36° C.) if the infant is kept too hot or too cold, and the temperature chart commonly shows a fluctuation of one or more degrees Fahrenheit under normal circumstances.

Pulse. The pulse-rate shows a general tendency to decrease with age throughout infancy and childhood, but during the first few days after birth the heart rate slows appreciably, though remaining well over 100 per minute. By the ninth or tenth day it has again reached the fœtal rate (135 to 160 per minute), and during the latter part of the newborn period a rate of 140 per minute may be given as an approximate average. Individual differences under standard conditions during this time are considerable, whilst wakefulness or crying will result in a prompt increase in pulse rate. Interpolated extra systoles have been described in a considerable proportion of normal newborn infants during the first week of life.

Respiration. During the newborn period the respiratory rhythm is frequently irregular, though prolonged periods of apnœa or recurrent cyanosis should be regarded as pathological. Whilst post-mortem findings in infants dying during the neonatal period must be interpreted with caution, the appearances of the lungs in such cases suggest that pulmonary expansion is probably not complete with the first breaths, and that the lungs normally contain gradually diminishing areas of atelectasis until full expansion has occurred during the third week.

Cry. The healthy infant usually cries within a few seconds of taking the first breath ; failure to do so may be due to prolonged asphyxia, birth trauma, or the use of anæsthesia during labour. The first cry serves to expand the lungs. Crying subsequently occurs when the infant is hungry or uncomfortable, and usually when it is being bathed. The pitch and quality of the cry in the neonatal period are characteristic, and any departure from the normal, *e.g.*, feebleness or moaning quality, calls for investigation of the infant's general condition.

Reflexes. Apart from the reflexes involved in crying, sucking, swallowing, yawning, respiration, digestion, defæcation, and micturition, the newborn infant should show certain well-defined reflexes whose absence is an indication of prematurity, birth injury or congenital abnormality.

The *grasp reflex* is much more vigorous in the newborn than in the older infant, and may be so strong that the infant, grasping the examiner's fingers, can actually be lifted off the couch. A grasp reflex of the foot has also been described (Brain and Curran, 1932).

The *Moro* (' *embrace* ') *reflex* consists of a sudden abduction and extension of the arms and legs, which may be followed by adduction and flexion of the arms. The reflex is elicited by placing the infant on its back, and sharply striking the couch on either side of the infant. The reflex is diminished or absent in cases where there is generalized flaccidity (*e.g.*, due to intracranial damage) or to peripheral nerve injury (*e.g.*, brachial palsy).

The *tendon reflexes* are normally present in the newborn, though it may require some patience to elicit them, since muscle tone is readily influenced by hunger or discomfort.

The *plantar reflexes* are frequently extensor during the first year of life, though it is thought that the extensor response of the infant is different in nature from Babinski's sign in later life.

The *abdominal reflexes* are not usually present in the newborn, but Ford (1946) states that an atypical reaction, which is diffuse and probably different from the adult response, may be obtained in about one-third of newborn infants.

The *reflexes of posture and equilibrium* have been studied in detail by Magnus (whose work has been reviewed by Walshe, 1924); certain of the responses found in the newborn infant indicate that stimuli are received from the labyrinths and proprioceptive nerve endings of muscles and joints at this age. The *tonic neck reflex* is normally present.

The *pupils* react to strong light, the newborn infant's normal response to light being a firm closure of the eyes. Sometimes, however, there is a vague attempt to follow a light with the eyes even during the newborn period.

Ford (1946) points out that there are many analogies between the newborn infant and the decerebrate animal; and that the motor reactions of the newborn are essentially reflex.

Sensibility is limited and hearing probably minimal at this age, though some response to loud noises can be elicited. The newborn reacts to painful stimuli, hunger, and cold, by crying. Hunger appears to be the sensation that is most readily appreciated.

Circulation. Whilst the change from intra-uterine to extra-uterine life involves a major readjustment of the fœtal circulation (see p. 54), the anatomical closure of the ductus arteriosus and foramen ovale takes place much more gradually than their functional disuse. Recent studies on the ductus arteriosus indicate that its complete obliteration occurs at a variable time after birth, and ‘anatomical patency’ has been found considerably beyond the newborn period in the majority of cases. Jager and Wollenman (1942) have described a process of obliteration in which the interior of the duct is thrown into mounds containing smooth muscle and elastic fibres, which are subsequently replaced by collagen and fibrous tissue. The foramen ovale does not show complete anatomical closure until at least six months after birth. Recent evidence, however, indicates that this anatomical patency has, in both instances, very little functional importance after birth.

The effect of early and late clamping of the cord on the blood volume has been studied by De Marsh *et al.* (1942), and it has been shown that if the cord is clamped early, before uterine contraction has compressed the placenta and so transfused the placental and cord blood into the infant's circulation, over 100 c.c. of blood are lost to the infant. The same authors found that in infants allowed to retrieve their placental blood, the blood-volume between birth and the third day averaged 361 c.c. (or 11·8 per cent. of body-weight) as compared with 301 c.c. (9·6 per cent. of body-weight) when the cord was clamped immediately. The hæmatocrit value of the blood was 60 per cent. and 51 per cent. respectively, though the plasma volume in both cases was approximately the same. More recent studies, however, make it appear doubtful if this difference persists for more than the first month of life or has an appreciable effect on the subsequent well-being of the infant (Selander, 1944).

Blood. Although the observations of different authors on the blood during the newborn period vary very considerably, certain general statements may be made. The blood at birth has relatively high hæmoglobin and red cell contents, both of which fall during the first month of life. Erythroblasts and nucleated and immature red cells are found in the peripheral blood on the first day of life, but disappear rapidly. The fragility of the red cells at birth is increased. There is little tendency to rouleaux formation and the blood is abnormally ‘sticky’ at this time. Enumeration of the white blood cells has shown very great variations, not only in different infants but in the same infants at different times.

Marriot and Davidson (1933) found a mean value of 5·95 million red cells per c.mm. on the first day, 5·19 at one month and 4·74 at two months; they concluded that a period of more than one month was required for the initial red cell adjustment. Their mean values for reticulocytes per cent. were 3·40 at birth, 0·17 at one week, and 0·10 at one month. In referring to the great variations in red cell counts at birth reported by different authors, Wollstein (1933) quoted extremes of 4 and 9 millions per c.mm., and assessed the average as from 5 to 5·5 millions. Whilst variations in the size of the red cells are commonly found at birth, these variations gradually disappear during the first and second weeks. Mackay (1933) gave 'normal' hæmoglobin values of 143 per cent. on the first day of life, 130 per cent. on the eighth day, and 106 per cent. at two weeks to one month. The Aberdeen Survey (see p. 8) showed average hæmoglobin values of 144·9 per cent. at birth, 132·7 per cent. at eight days, and 90·8 per cent. at one month.

Washburn (1934) studied the leucocyte counts in healthy infants aged one to sixteen weeks, and found extreme variation in the total counts (4 to 23 thousand) without evidence of disease, whilst the daily and hourly variations for individual babies were extremely irregular ; he found that the variations lay principally in the numbers of lymphocytes, which tended to parallel the total counts.

Prothrombin Level. Considerable interest has recently been attached to the prothrombin level during the newborn period, particularly in relation to the occurrence of hæmorrhage and the influence of vitamin K administration. It has been shown that the cord blood plasma of the normal infant has a similar prothrombin level to that of the maternal blood plasma, but that a progressive fall occurs in the prothrombin level of the infant's plasma during the first three days of life. During the subsequent three to four days this returns to normal. The clotting time during the period of physiological hypothrombinæmia is frequently normal, but may be increased without hæmorrhage occurring. It is found that the administration of vitamin K to the mother before delivery or to the infant at birth will diminish or eliminate the fall in prothrombin level, but since there does not appear to be a simple relationship between prothrombin level, clotting time, and a tendency to hæmorrhage, it cannot be said with confidence that the routine prophylactic use of vitamin K is necessary or reliable in preventing hæmorrhage in the newborn period. Vitamin K does, however, appear to have definite value in the treatment of hæmorrhagic disease of the newborn, though its value is probably not equal to that of blood transfusion.

Physiological Jaundice of the Newborn. Jaundice is detectable clinically on the second or third day in the majority of newborn infants, and clears gradually in from one to four weeks or occasionally longer. Goldbloom and Gottlieb (1929) found that blood from the umbilical cord and the peripheral blood of the infant at birth gave a positive Van den Bergh reaction in all cases, and considered the division of newborns into those with and those without clinical jaundice an artificial one. The hyperbilirubinæmia of the newborn has been regarded as being hæmolytic in origin, and associated with increased fragility of the red cells during the first week, though the correlation between the degree of jaundice and the fall in hæmoglobin and red cells during the newborn period is not a close one. It is probable, however, that the explanation of the jaundice lies rather in the immaturity of the liver cells, since the production of bilirubin, though proportionately two to three times as great as in the adult (Mollison, 1948), would not overtax the liver's powers of excretion if the cells were functioning to adult capacity.

The Care of the Infant at Birth

Even when labour has been perfectly straightforward, the infant will have suffered some degree of shock and ' physiological trauma ' during the birth passage, to which the moulding of the head and the common finding of red cells in the cerebrospinal fluid (Roberts, 1924 ; Ehrenfest, 1931) bear evidence. It follows that the greatest care must be taken to avoid chilling and rough handling immediately after birth, whilst in the case of breech deliveries the infant's body must be kept warm during delivery of the head in order to avoid any extra stimulus to premature respiration and inhalation of liquor amnii. The infant should be wrapped up warmly as soon as practicable ; there is no urgency about the ritual bathing unless infection of the maternal passages is suspected, and the grandmaternal admiration can be left till later.

Umbilical Cord. Clamping of the cord may normally be carried out when the placenta has been sufficiently compressed by the contracting uterus, although the value of the blood lost by early clamping is open to question except in the case of prematures. It is not always advisable to wait until pulsation in the cord has ceased, since the duration of pulsation is very variable, and long delay may lead to chilling of the infant. Pulsation may, in fact, continue after the cord has been cut. After clamping it should be firmly ligatured with sterile thread about 4 inches from the umbilicus, and cut with sterile scissors an inch beyond the ligature. Only a very small quantity of blood should ooze from the cut end, and if oozing continues, the cord must be religatured. It is essential to keep a careful watch on the dressings throughout the first week, since any recurrence of oozing indicates either that the ligature has become insecure or that the infant is suffering from hæmorrhagic disease or sepsis.

The cut end of the cord should immediately be covered with sterile gauze and subsequently dressed, using sterile powder and gauze, kept in place with a thin flannel or crepe binder, which should not restrict respiration. Scrupulous cleanliness and the use of sterile dressings and instruments is essential, since umbilical sepsis may easily prove fatal. Use of contaminated Fuller's earth as a dressing, for instance, has been known to cause a disastrous outbreak of neonatal tetanus.

The cord usually separates in from five to ten days. In one hundred consecutive live-born infants, the average time of separation was found to be 7·3 days, extremes being three days (1 case) and seventeen days (1 case).

Respiratory Passages. Obstruction of the respiratory passages by inhalation of liquor amnii or blood is an important cause of delay in the establishment of respiration and may result in atelectasis. In most cases, careful swabbing of the mouth with sterile cotton wool (which should be carried out with extreme gentleness) and positional drainage will be all that is required. Before the cord has been cut, the infant can be laid on its back across the mother's thigh, so that the head and arms hang down, fluid can drain freely from the lungs, and the chest can expand readily. It is always advisable to have available a small soft rubber catheter attached to a glass 'trap,' so that fluid can be sucked out of the nasopharynx if necessary. Blaikely and Gibberd (1935) have designed a miniature laryngoscope, by means of which the larynx can be intubated under direct vision for the purpose of aspirating fluid from the bronchi and the administration of oxygen. This procedure needs to be carried out with great care to avoid trauma to the glottis, and is not required in the normal infant.

Respiration and Asphyxia. The normal establishment of respiration at birth has already been discussed (p. 58), and fortunately it usually occurs within a few seconds or minutes without outside aid. Infants born by Cæsarean section may take slightly longer to breathe than those delivered normally, partly owing to the lower concentration of CO_2 in the blood-stream.

In the case of infants who fail to breathe spontaneously, the methods employed to stimulate respiration have changed radically in recent years with the clearer understanding of the physiological principles involved. The more horrific methods of attempting to induce respiration, with their attendant dangers of fractured ribs or a ruptured viscus, have been largely abandoned; and it is certain that many of the babies who have finally breathed after continued slapping, squeezing, swinging through the air, or douching with cold water, have done so in spite of these procedures rather than because of them. Even mouth-to-mouth insufflation has been found to be of very limited value, and accompanied by a considerable danger of overdistension or even rupture of the stomach, emphysema or infection.

Plus fait douceur que violence is an admirable motto in dealing with the newborn, and whilst peripheral stimulation may, and probably does, have a certain place in the establishment of respiration, it should only be applied in a manner that at least can do no harm. Since the primary need of the newborn is for oxygen, a valuable procedure is to play a strong stream of oxygen on the infant's face through a funnel (Barcroft, 1942); this has the double advantage of providing an atmosphere rich in oxygen when the first breath is taken, and of stimulating the fifth nerve. Sprinkling cold water on the face will also provide peripheral stimulation without undue chilling, whilst the time-honoured procedure of a single smack on the buttocks, if judiciously applied, may help to start the infant on the way it should go.

The use of 5 per cent. CO_2 in oxygen, for periods of five to ten minutes every hour, by means of a soft, close-fitting face-mask, may be of value in the case of an infant who has already breathed but in whom respiration is feeble and irregular. It does not, however, appear logical to use it before the first breath has been taken, and Eastman (1932) has shown that in the deeply asphyxiated infant who has not breathed the concentration of CO_2 has reached and passed the level at which it can be expected to act as a stimulant to the respiratory centre, and is in fact acting as a toxin.

Some degree of asphyxia is normally present at birth, and disappears rapidly once the first breath has been taken. More persistent and severe asphyxia, however, is likely to be associated with birth injury, congenital morbus cordis, or persistent atelectasis. The division of infants into those suffering from 'blue' and 'white' asphyxia has a certain practical value, if it is emphasized that the latter is the more severe and indicates a condition of profound shock. For the treatment of such cases, when respiration has once been established, an oxygen tent offers great advantages; a miniature tent can be improvized if necessary from an infant's gas-mask.

Skin. The skin of the infant at birth is covered with a variable amount of cheesy material or vernix caseosa. It is also wet with liquor amnii, and may be smeared with blood or meconium. The skin may be cleansed with a non-irritating soap (*e.g.*, Castile) and warm water, but the infant should not be placed in the bath until after the cord has separated. In the case of feeble infants and when there is much vernix caseosa cleansing is best carried out with warm olive oil, and some authorities recommend this in all cases. Chilling must be avoided. The eyelids should be cleansed with wet cotton wool, and it is a common practice to instil 2 drops of 1 per cent. silver nitrate into the conjunctival sac ; it should then be washed out with normal saline. However, the use of silver nitrate is of doubtful value, and may result in a non-infective chemical conjunctivitis or 'sticky eyes' during the neonatal period, since if the conjunctival sac is not washed out, a drop may remain in the inner canthus and evaporate, leaving a solution considerably stronger than 1 per cent. After the skin has been washed and dried, the flexures should be powdered, *e.g.*, with zinc and boracic powder. Subsequently the infant should be washed or oiled every day, paying particular attention to the napkin area. The nails should be cut short and kept clean. Wisps of cotton wool may be used for cleaning the nostrils and ears. Any rash during the neonatal period should be carefully noted and the cause sought, *e.g.*, congenital syphilis, maternal scabies, or sepsis. Skin sepsis during this period is particularly dangerous, and great care must be taken to keep the infant's washing utensils separate and clean.

General Examination. Shortly after birth the infant should be thoroughly examined in a good light. Any congenital abnormality such as club foot, cleft palate, or congenital morbus cordis, and any evidence of birth injury, should be noted. It is most important to make certain that the orifices are patent, and that the infant passes urine and meconium during the first twenty-four hours. The abdomen should be palpated to make sure that the bladder is not distended. The presence of a pilonoidal depression at the base of the spine is not of clinical importance unless it leads to a true sinus. The genitalia and inguinal regions should be examined to exclude hernia, hydrocele, maldescent of the testicles, or adhesions of the labia.

Birth marks should be noted. If either parent has Mongolian or Negro blood, it should be remembered that 'Mongolian blue spots' may be present on the buttocks or sacral area and are apt to be mistaken for ecchymoses.

The cot or bassinette should be as simple as possible, and easily portable. For hospital use, a metal-frame cot covered with washable material has obvious advantages, but it must be warmly lined and not allowed to stand in a draught. It should contain a washable, mackintosh-covered mattress. Hot-water bottles must be well covered, and never allowed to come in direct contact with the infant.

Clothing. The clothing of the infant should be warm and should allow movement; it must be easily changeable, washable, and non-irritating. The following layette is found generally satisfactory :—

Napkins can be made from a 24-inch (61 cm.) square of double-thickness butter-muslin. This is folded once, making a strip 12 × 24 inches, and 8 inches at one end is then folded forward. The baby is placed on his back on the singly folded portion. (If a supply of old cotton sheeting is available, a square can be placed under the baby's buttocks and discarded when a stool is passed.) The doubly folded portion is then brought forward between the infant's legs and pinned at the sides. It is important that the napkin should not be too tightly applied or force the thighs into an uncomfortable position. If these napkins above are used, about four dozen will be required. A layer of soft towelling can be applied outside the napkin, being pinned round the waist and coming down as a skirt to the level of the knees. When towelling is used in addition to napkins, the total number of inner napkins can be correspondingly reduced.

Three light woollen vests, made with short sleeves, and fastening with tapes down the front.

Three long-sleeved gowns of thin flannel or viyella, fastening with tapes down the back, and descending well below the feet.

Three knitted wool jackets.

Two flannel or woollen wraps.

A cap is unnecessary for the full-term infant indoors.

Contact. The number of persons in contact with the newborn baby should be reduced to a minimum. The procedure in newborn nurseries is considered in Chapter XVI. Kissing, coughing, sneezing and spitting over the infant are particularly objectionable, and although the newborn appears to have a somewhat higher immunity to upper respiratory infection than the older infant, infection acquired in this way may prove fatal.

If the infant has to be cared for in a house where it is impossible to get rid of flies, the cot and all feeding and washing utensils should be covered with butter-muslin.

Feeding is discussed in Chapter IV. The actual time after birth at which the infant is first put to the breast will have to depend to some extent on the state of the mother, but it is usually possible to allow the baby to nurse for a few minutes six or eight hours after delivery.

Care of the Premature Infant. The same general principles apply to the care of the premature as to that of the full-term infant at birth, but owing to the immaturity of all the tissues, additional precautions are necessary. Thus the premature is even less able to regulate its body temperature, and must be kept warmer than the full-term infant but not overheated. Crosse (1945) recommends a cot temperature of 90°–95° F. (32°–35° C.) for the smallest infants, and 85°–90° F. (30°–32° C.) for the larger and more robust. (The temperature and humidity of the nursery is discussed in Chapter XVI.) Close supervision of feeble infants is essential, and they should always be nursed lying on the side, owing to the danger of inhalation of vomitus.

Establishment and maintenance of respiration is likely to prove a greater difficulty in the case of the premature infant, and the routine use of oxygen for the smaller and more feeble is advisable. Regular administration of CO_2 in oxygen (see above) is likely to be required in these cases, owing to the increased likelihood of atelectasis and recurrent cyanosis. In the establishment of respiration, it is of prime importance that the utmost gentleness in handling the infant should be used. Indeed, all handling of the premature should be reduced to a minimum. Similarly, clearing of the upper respiratory passages of mucus and liquor must be carried out with greater care, as swabbing of the mouth is liable to injure the mucosa.

Feeding of the premature is apt to present peculiar difficulties, and calls for a high standard of nursing skill. Not only is the anatomical and functional capacity of the stomach limited, but the general feebleness of the infant may render prolonged or vigorous sucking impossible. Prematures may be divided into those who can suck and swallow, those who can only suck extremely feebly but can swallow normally, and those who have difficulty in both sucking and swallowing. The first group can be fed by a bottle fitted with a small ‘ premature ’ teat, and can often be put to the breast relatively soon ; the second group must be fed by pipette, or a double-teated bottle from which milk can be gently expressed into the infant mouth whilst it is sucking ; the third group will at first have to have all feeds given by tube. It is highly desirable that prematures should if possible be given breast milk with added protein, though this will require dilution at first for the smaller infants. Feeds will have to be given more frequently than in the case of full-term infants, the smallest infants sometimes requiring to be fed 1½ to 2 hourly throughout the twenty-four hours. It should be remembered, however, that quantitative over-feeding during the first few days is a greater danger than under-feeding, and also that it is even more important to avoid dehydration than in the case of the full-term infant. Owing to the greater liability of the premature baby to develop deficiency diseases, vitamins A, C and D should be added to the diet in concentrated form, starting during the neonatal period. The routine administration of vitamin K to premature babies, in whom the liability to hæmorrhage is considerable, is on a firmer foundation than the prophylactic administration to full-term infants; when premature delivery is expected, the mother should be given vitamin K before the end of pregnancy, and the infant should receive 0·5 to 1 mg. (Crosse, 1945) within six to eight hours of birth.

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CHAPTER IV

DIGESTION, NUTRITION AND FEEDING

Much ill-health in childhood is attributed to digestive upsets, lack of appetite, and irregular bowel-action. Whilst some of these digestive disturbances are the result of improper diet, others are due to emotional or environmental factors, or to parenteral infection. Before considering digestion and nutrition in detail, the following aims and principles in the feeding of infants and children may be stated :—

(1) That proper feeding habits should be established in infancy, with the corollary that healthy appetite should be present in childhood.

(2) That the diet should be adequate in total calories and bulk, and should cover the nutritional requirements in essential constituents.

(3) That the diet should be palatable and properly cooked, and that after early infancy the child should be given choice and variety.

(4) That digestion should take place with a minimum of disturbance, *e.g.*, infants should be warm, comfortable, and at rest both during and after a feed, and children should be allowed a reasonable time for their meals and for rest afterwards. The adverse effect on digestion of making each meal-time a battle of wills should hardly need emphasis.

(5) That regular bowel action should be established early as a normal habit without the use of laxatives.

Digestion

The digestive tract of the infant differs in several respects from that of the older child, and its capacity is correspondingly limited. The absence of teeth excludes the chewing of solid food, and although saliva is excreted at birth, salivary digestion in early infancy is negligible. Food in liquid form, *i.e.*, milk, is normally obtained by sucking, a reflex act at first consisting of regular and co-ordinated movement of the jaws (later associated with inspiration), and controlled by a centre in the medulla. This reflex begins to disappear in the latter part of the first year. Swallowing also occurs as a reflex act, and is stimulated when sufficient milk has been ingested to flood the floor of the mouth and reach the uvula. It is known that in later life the act of swallowing causes a reflex inhibition of respiration, and whilst the same is probably true in the infant, the regularity of the swallowing during feeding causes less obvious disturbance of respiratory rhythm. Swallowing usually bears a 1 : 1 or 2 : 1 ratio to the respiratory cycle, being followed regularly either by inspiration or expiration, or alternatively by first one and then the other (Wolman, 1944).

The stomach at birth and during early infancy lies with its long axis placed transversely, and only gradually reaches the adult form and position at the age of about eleven years ; at this time it tends to descend below the iliac crests (Wright, 1924). Its capacity has been estimated as 30 to 35 c.c. at birth, increasing to 45 c.c. within four days, 75 c.c. in the second week, and 100 c.c. at the end of the first month ; in the case of an organ of such varying tonicity as the stomach, however, such figures can only be regarded as rough averages during life.

When the stomach is filled, the cardiac sphincter closes, and there is tonic contraction of the fundus around the food. Waves of contraction are rapidly stimulated. These first originate near the pylorus and subsequently at the cardiac end of the stomach, passing towards the pylorus. (These can be well seen in the infant with pyloric stenosis, when a bulging area followed by a wave of contraction is seen passing across the abdomen from the left hypochondrium to a point approximately 1 inch above and to the right of the umbilicus.) The pyloric sphincter opens intermittently, passing small quantities of food into the duodenum. Since the food is entirely fluid in early infancy, the stomach empties more rapidly than in the adult ; radiological studies have shown that the meal may begin to pass the pylorus within five minutes, and the stomach is normally empty in from one to three hours (Ladd, 1913 ; Pisek and Le Wald, 1913).

It should be emphasized that the rate of emptying of the stomach varies considerably in different infants, and that ' hunger-waves ' (see below) will therefore appear sooner after a feed in one than in another. The emptying time is also found to vary with position (being longest when the infant is lying on its back), and with the composition of the feed, breast-milk usually being evacuated more rapidly than an artificial feed. Emotional factors and parenteral disease may also profoundly modify gastric motility ; these will usually tend to reduce motility, delay the emptying time, and so diminish appetite, whilst if the disturbance is severe, vomiting may be initiated.

' *Hunger contractions* ' and increased tonus of the stomach occur when the stomach is empty. They are more frequent and intense, and occur sooner in the infant, than in the adult, appearing at intervals of ten to fifteen minutes (Carlson and Ginsburg, 1915), or even at intervals of less than five minutes in the newborn (Taylor, 1917). Taylor gave the average interval between feeding and the next hunger period in the newborn full-term infant as two hours fifty mintes, with a maximum of four hours and a minimum of two hours, as compared with an average of three hours fifty minutes (maximum four hours thirty-five minutes and minimum three hours twelve minutes) in infants aged two weeks to four months. The recognition of the physiological basis, variability, and intensity of hunger in the infant is essential for rational infant feeding.

In older children, the interval between taking food and the appearance of hunger contractions is longer. The influence of psychological factors on appetite will be discussed subsequently, but it should be remembered from the physiological aspect that for a healthy appetite to develop, the stomach must be given a reasonable time to empty after a meal. An excess of fat in the diet will also tend to delay gastric emptying, and so reduce appetite.

When starchy foods have been introduced into the diet, salivary digestion will be called into play. But in the milk-fed infant digestion begins in the stomach with the clotting of the caseinogen fraction of the milk by the action of pepsin in the presence of calcium. (The occurrence of rennin in the stomach of the human infant is doubtful.) Pepsin begins the breakdown of protein into proteoses and peptones, but the digestion of protein in the infant's stomach is very incomplete. Pepsin is activated by hydrochloric acid, which is present in the gastric secretion at birth, though the gastric glands are relatively less numerous than in later life (Scott, 1925). Miller (1941, 1942) found that, in the neonatal period, the development of the gastric mucosa and the amount of acid secreted bears a close relationship to the birth weight, and that the gastric acidity falls during the first ten days of life. After this age he described a gradual rise, with an increase in concentration and probably an increase in volume during the first year.

Marriott (1935) found that since the buffering action of cow's milk is three times as great as that of human milk, and the curd tougher, a reaction of *p*H 3·6 occurred at the height of gastric digestion in the breast-fed baby as compared with an average value of *p*H 5·3 in babies receiving undiluted cow's milk. Since the former acidity is sufficient to have an appreciable bacteriacidal action on ingested organisms, it will be seen that breast-feeding (1) favours peptic digestion and (2) tends to reduce infection of the gastro-intestinal tract.

A gastric lipase, or fat-splitting enzyme, is also present in the gastric secretion at birth ; Freudenberg (1927) has described an activator which he calls lipokinase, and also a gastric enzyme, cathepsin, acting on casein and lactalbumin (Freudenberg and Buchs, 1940 ; Freudenberg, 1940). Absorption from the stomach in infancy is minimal.

Air-swallowing is a normal procedure in the infant, and Bouslog *et al.* (1935) showed radiologically that air might enter the stomach with the first inspiration. Some degree of air-swallowing always occurs during feeding, and if not excessive, the gas-bubble rises to the fundus of the stomach and is eructated by the infant during or after the feed. This is facilitated by holding the baby erect after the feed until eructation has occurred. If the infant is placed on its left side immediately after feeding, the air tends to fill the pyloric end of the stomach, and to pass through the pylorus with the food ; this gives rise to distension of the small bowel and discomfort. The management of air-swallowing in infant feeding is considered subsequently (see p. 92).

The small intestine is 300 to 350 cm. in length at birth (Scammon, 1923), approximately 450 cm. at one year, and 600 to 700 cm. at puberty. In the infant, the first part of the duodenum when filled has the appearance of a straight horizontal tube (Wolman, 1944), later assuming the adult form. Movement in the small intestine in childhood is thought to be similar to that described in the adult, but, as in the case of the stomach, the intestinal movement of the young child is much more susceptible to outside influences. Apart from the movement of the villi, which serves to empty the central lacteals and facilitate absorption, three types of movement have been described : rhythmic segmentation, pendulum or swaying movements, and ‘ travel wave ’ or ‘ peristaltic rush.’ The last of these is particularly readily excited in infants and young children, with the result that diarrhœa may follow such different stimuli as fright, infection, or even the taking of food.

Studies of duodenal content have been carried out in infants by Klumpp and Neale (1930) and in the newborn by Hess (1912) ; the former authors found that the duodenal *p*H was 7 at all ages, and that the acidity rose to *p*H 5 in a constant manner after a cream meal. The greater part of digestion takes place in the jejunum. Fat is hydrolysed (*i.e.*, split into glycerol and fatty acids) by the action of pancreatic lipase after emulsification in the presence of bile salts. Lipolytic activity is, however, low, particularly during the first year of life. The disaccharide lactose, the sugar contained in milk, is converted into the monosaccharides glucose and galactose which are capable of being absorbed directly into the blood-stream. It is uncertain, however, what proportion of the lactose is converted into monosaccharides in the infant's gut ; in the adult, it is known that ingested lactose causes little or no rise in blood-sugar and that a certain amount of lactose reaches the colon unchanged. In the infant, the addition of lactose to a cow's-milk formula favours the production of an acid stool and the growth of *Bacillus acidophilus*, and tends to facilitate the absorption of calcium. It is probable therefore that only a limited amount of lactose is converted into monosaccharides in the jejunum, the remainder forming lactic acid by bacterial action.

Amylase, the enzyme serving to break down starch, has not been constantly found in the gut of young infants, though it is present in considerable amount in older infants. Klumpp and Neale found extremely low amylotic values below the age of twelve months, with a sudden increase after the first year and again between nine and twelve years.

Protein digestion in the infant is similar to that in the adult, but the infant's capacity in this respect is limited, and cases of protein indigestion in artificially fed infants may occur.

Absorption of the products of digestion takes place at various levels through the intestinal villi.

The liver has an average weight of 135 g. at birth, and since the anterior margin descends well below the right costal margin, it is normally palpable in early infancy. It is not clearly differentiated into lobules at this age, the lobular structure only becoming well defined in the latter part of the first year. Apart from its metabolic functions and capacity for storage of products of digestion, the liver serves as an important site of blood-formation during fœtal life, and as a reservoir for blood and for the iron necessary for hæmoglobin formation. It also forms prothrombin and fibrogen, and serves a detoxicating function. If circulating toxins are present in excess, the liver is liable to suffer fatty degeneration.

The principal metabolic functions of the liver are (1) glycogen storage and release, (2) the intermediary metabolism of fat, (3) the excretion of bile, (4) the deaminization of amino-acids, and (5) the conversion of protein into carbohydrate.

(1) Glucose absorbed from the intestine is stored in the liver as glycogen, and released again into the blood-stream when required for metabolism and oxidation in the tissues. The storage and release of glucose are controlled by the action of insulin, of the principle of the anterior pituitary, and of adrenaline, the last of

these stimulating release. In childhood, the high rate of metabolism results in frequent calls for available carbohydrate, and the glycogen stores of the liver become readily depleted (see p. 85).

(2) The intermediary metabolism of fat is carried out by the liver, and it is probable that this is the only organ possessing the necessary enzyme-system for the purpose. Whilst the formation of ketone bodies is a normal stage in fat metabolism, these substances do not appear in the blood and urine in considerable amount except when the capacity of the liver for the metabolism of fat is overtaxed. This is likely to occur when the liver is deprived of carbohydrate, since in the presence of carbohydrate fat will be stored. The view that carbohydrate is necessary for the complete metabolism of fat is no longer held ; it appears rather that in the absence of carbohydrate the liver is called on to metabolize more fat than it can completely break down, and a certain proportion is reduced only to the stage of ketone bodies. That the liver can under certain circumstances become adapted to a ‘ ketogenic ’ diet is seen in the Eskimo, where a diet consisting very largely of fat and containing little or no carbohydrate fails to produce ketonuria.

Children develop ketonuria very much more readily than do adults, and it is regrettable that the presence of ketone bodies in the urine is often incorrectly described as ‘ acidosis ’ and regarded as the explanation of such other symptoms as vomiting and lassitude, which may be present at the same time. If the true significance of ketonuria, viz. evidence of the incomplete combustion of fat, is kept in mind, the primary cause of the hepatic dysfunction is less likely to be overlooked. It has repeatedly been shown that ketonuria can be artificially induced in most children without causing vomiting, and even some cases of cyclical vomiting may tolerate a ketogenic diet, causing a marked ketonuria, without any of the symptoms of a bilious attack being produced (Ellis, 1931). For practical purposes, however, it is true that the appearance of ketosis is an indication for giving carbohydrate, whether the ketosis is due to simple carbohydrate deprivation or liver dysfunction secondary to infection. When a loading dose of glucose is first given to a child with ketosis who has been on a ketogenic diet, it is found that the blood-sugar rises to hyperglycæmic levels and sugar appears in the urine ; a second loading dose after the blood-sugar has returned to normal, however, is followed by little or no rise in blood-sugar. This probably indicates that in the first instance the liver is so exclusively taken up with the metabolism of fat, that glycogen cannot immediately be stored, whereas when the second dose of glucose is given, the liver is readjusted to glycogen storage and glucose is removed from the blood-stream more rapidly than normally in order to make good the depleted glycogen stores (Ellis, 1931).

(3) The excretion of bile. Colloidal bilirubin is formed from the breakdown of red cells by the reticulo-endothelial cells in the liver, spleen, bone-marrow and lymph-glands ; it is taken up by the Küpffer cells of the liver and excreted as soluble bilirubin. Both bile pigments and salts are produced during fœtal life, and bile has been demonstrated in the duodenum of the newborn before food has been ingested (Hess, 1912). Geptner (1900) has shown that the bile is less viscid in early infancy, the percentage of solids being 6·42, as compared with 17·03 in the adult.

(4) and (5). The final breakdown (deaminization) of the constituent amino-acids of protein takes place in the liver. Whilst a basic amount of protein is necessary for the replacement of protein-breakdown of the body tissues, and a relatively larger amount required for growth in childhood than in adult life, a substantial proportion of excess protein is converted into carbohydrate by the liver. The extent to which this latter process takes place will of course depend on how amply the requirements of essential amino-acids are covered by the diet.

The Pancreas. The internal secretion of the Islets of Langerhans, insulin, is produced during fœtal life, and the islets are not only functional at birth but may be hypertrophied, giving rise to neonatal hypoglycæmia, in the infants of diabetic mothers. In the exocrine secretion, the pancreatic juice, trypsinogen and lipase have been identified as early as the fourth fœtal month (Needham, 1931), whilst the low amylotic activity during the first year of life has already been mentioned.

The large intestine is relatively more capacious in the infant than in the adult, and owing to the more liquid character of the food, probably plays a more important *rôle* in the absorption of fluid. Apart from this, digestion is completed by the time the intestinal contents pass the ileo-colic sphincter.

Defæcation. This is a reflex act which is not under voluntary control in early infancy, when it commonly occurs three or more times a day, or even after each feed. Sphincter control is not acquired until the stools are becoming formed, and since voluntary control is necessarily established gradually, it is understandable that it is less perfect, and less well able to withstand every sea of troubles, in young children than in adult life.

When control is firmly established, most children adopt a defæcatory rhythm of one bowel action a day at approximately the same hour, but it should be emphasized that either a more or a less frequent rhythm is quite consistent with perfect health. ‘Constipation’ and ‘diarrhœa’ should be judged not by the frequency of bowel actions (unless there is a sudden interference with the child’s normal rhythm) so much as by the consistency of the stools.

Stools. At birth the gut contains meconium, which is semi-fluid, viscid, and dark green in colour. The colour is due to the presence of bile pigments (the meconium being pasty-coloured in infants born with congenital obliteration of the bile-ducts), and the material consists of swallowed amniotic fluid, desquamated cells, and the digestive secretions. Meconium is practically odourless and sterile at birth.

During the first ten days of life, the stools gradually change to the consistency and yellowish colour of custard, which they maintain for the first four or five months. They are slightly greasy, owing to the relatively high fat content (approximately 35 to 40 per cent. of the dried stool), and have a sour smell; they lack the fæcal odour of the stools in later life, which is due to the presence of indol and skatol and to the action of putrefactive bacteria in the large gut. The infant’s stool normally contains 85 per cent. water, only very small amounts of protein, and no sugar. Approximately 10 per cent. of the dried stool consists of mineral matter. If undigested curds are present, it is an indication that the food is passing too rapidly, or that the cow’s milk curd is proving too tough for the digestive enzymes.

The reaction of the stool in the case of breast-fed babies is acid, but in artificially fed infants it is usually neutral or faintly alkaline, though the exact composition of the feed may result in some variation in reaction, *e.g.*, the addition of lactose tending to produce an acid stool. This difference in reaction is thought to be at least partly responsible for the difference in flora of the breast-fed and artificially fed infant’s stool.

The stools become darker in colour during the second six months of life, and after eight months may be becoming formed; in the case of many normal infants, however, the stools are not formed until the second year. They then assume the colour and odour of the adult stool.

Intestinal Flora. Whilst the meconium is normally sterile at birth, intestinal bacteria make their appearance rapidly after food has been ingested; the upper part of the small intestine remains free from organisms for a longer time in the breast-fed than in the artificially fed infant, possibly due to the higher gastric acidity in the former. There is also a striking difference between the character of the fæcal flora of the breast-fed and that of the artificially fed infant, and it has been suggested that this may have a bearing on the relative freedom from gastro-intestinal upsets observed in breast-fed babies. Tissier (1900) and Kendall (1910) have shown that during the period of breast-feeding, the infant's stools are characterized by an almost pure growth of *Bacillus bifidus* (which may represent 99 per cent. of the fæcal organisms present), but this organism tends to disappear with the change to a mixed diet. Artificially fed infants, however, show a mixed fæcal flora throughout, including *B. acidophilus*, an organism similar to, but not identical with, *B. bifidus* (Crickshank, 1925).

During later infancy, the flora gradually changes to the mixed adult type.

Nutritional Requirements

Calories. When it is considered that the infant doubles his birth-weight in the first five or six months of life, it will be realized that his caloric requirements will be relatively much higher than those of an adult. They are supplied by 45 to 50 calories per pound body weight per day during the first six months and by 45 per pound (100 per kilo) during the second, as compared with the needs of a man weighing 154 lb. (70 kilos) on moderately active work who requires 3,000 calories, *i.e.*, approximately 20 calories per lb. (43 per kilo). Throughout childhood the caloric requirements remain high, in order to supply the calls of both growth and energy. The following daily allowances for older infants and children are given by the Food and Nutrition Board, National Research Council :—

1 to 3 years	1,200 calories
4 to 6 years	1,600 calories
7 to 9 years	2,000 calories
10 to 12 years	2,500 calories
Girls, 13 to 15 years	2,800 calories
Boys, 13 to 15 years	3,200 calories

Fluid. The infant requires approximately 2 to 2½ fluid ounces per pound body-weight per day (125 to 156 c.c. per kilo), though in the newborn period the requirements are slightly less. In older infants and children, temperature and activity will cause great variation. Whilst thirst is usually a reliable guide, it is sometimes found that a child who is constipated, with dry hard stools, is suffering from excessive fluid absorption in the large bowel and that the condition can be relieved by a higher fluid intake. It has been estimated (Blackfan *et al.*, 1932) that average fluid requirements are 120 to 135 c.c. per kilo per day at one year, 100 to 110 c.c. at four years, and 50 to 60 c.c. at fourteen years.

Protein, Fat and Carbohydrate. Whilst fat and carbohydrate are the main sources of energy, and are to some extent interchangeable in metabolism, protein is essential for growth and the replacement of protein-breakdown which is continually going on in the tissues of the body. Protein cannot be entirely manufactured from fat and carbohydrate, and the food must therefore contain sufficient protein to supply the requirement of essential amino-acids, both for growth and maintenance. A correct balance of essential amino-acids is also necessary.

The *protein* requirements of the infant cannot be accurately assessed in terms of total protein, since the biological value of different proteins varies considerably. Thus the breast-fed baby thrives on only 1·8 to 2·3 g. total protein per kilo per day (representing less than 10 per cent. of total calories), whereas babies artificially fed on cow's milk formulæ may show deficiency symptoms if the total protein falls below 2·6 to 3·5 g. per kilo body weight per day, representing 12 per cent. of total calories (Blackfan *et al.*, 1932). At least four amino-acids, all contained in the protein of milk, namely, lysine, tryptophane, cystine, and histidine, are known to be essential for growth.

In the diets of healthy normal children, it is found that protein usually represents at least 10 per cent. of total calories, though this is probably more than double the minimum requirements of first class protein. The total protein intake in childhood should not be less than 1 g. per kilo per day ; this is best insured by the inclusion of milk in the diet, though other foods rich in protein will of course normally be eaten in addition. Not less than half the total protein requirements should be in form of animal protein ; in early infancy all the protein is normally derived from milk.

Carbohydrate is the main source of glucose ; the latter circulates in the blood, providing for energy requirements, and is stored in the liver as glycogen. Owing to the rapid metabolism of childhood, the calls for rapidly assimilable carbohydrate are much higher than in the adult, and the craving of children for sweets, sugar, jam, and starchy foods is a perfectly proper one. If young children are kept for several hours without carbohydrate they are liable to develop symptoms of hypoglycæmia, whilst the tendency for them to show ketone bodies in the urine has already been referred to.

A too-exclusively carbohydrate diet, however, tends to produce fat rather than muscular development (see Infant Feeding, and the use of sweetened condensed milk).

The minimum carbohydrate requirements have been estimated as 3 g. per kilo per day for infants and 2·5 to 3 g. in the case of older children; the normal intake, however, of the healthy child is considerably higher (10 to 14 g. for infants and 8 to 10 for older children). Although the carbohydrate present in milk is lactose, artificially fed infants are able to digest other sugars such as cane sugar and dextrimaltose, and the employment of lactose in the artificial feeding of infants is not necessary. Lactose has, however, the slight advantage that it is less sweet than other sugars, whilst the effect on the stools has already been considered. It is possible also that some amount of lactose is necessary in the infant's diet for the synthesis of the galactolipins of the central nervous system.

Fat is, weight for weight, the most fruitful source of calories, and certain fats supply the fat-soluble vitamins. Human milk and cow's milk both contain 3·5 to 4 per cent. fat (the percentage varying considerably in different samples), yielding approximately half of the total calories. Whilst this amount is usually well tolerated in artificial feeding of young infants, cow's milk such as Jersey and Guernsey milks having a higher fat content should be avoided. In general, it is found that a high fat intake is not well tolerated in early childhood, and is liable to result in ketosis and in indigestion (probably related to the effect of fat in causing gastric and intestinal inertia).

Inorganic Elements. The inorganic elements required in diet are iron and iodine (for the formation of hæmoglobin and thyroxin respectively); calcium, sodium, potassium and magnesium (bases); phosphorus, sulphur and chlorine (acid radicles); and copper and possibly other elements in minute traces. All are contained in milk.

Iron is essential for the manufacture of hæmoglobin and for the growth of the blood-forming organs. Whilst the full-term infant is born with a considerable store of iron in the liver, this rapidly becomes exhausted unless constantly replaced; since this store of iron is principally laid down during the last two months of pregnancy, premature babies (and twins) are more liable to develop iron-deficiency anæmia at an early age than are full-term infants. The estimated daily iron-allowances (N.R.C.) are 6 mg. up to one year, 7 mg. at one to three years, and 12 mg. at ten to twelve years. There is usually no iron deficiency in a full-term infant on a milk diet up to the age of six months, but after this time it is important that iron-containing foods, such as bone and vegetable broth, eggs and liver, should be added to the diet. The average iron content of human milk has been estimated as 1·8 mg. per litre, and that of cow's milk as 0·5 mg. per litre (Bahrdt and Edelstein). It follows, therefore, that there is considerably more danger of iron-deficiency in babies fed on diluted cow's milk than in those that are breast-fed.

Calcium is necessary for growth of the skeletal system, and for maintenance of the blood calcium at the normal level (9 to 11 mg. per cent.). When there is gross deficiency of calcium in the diet, or failure of utilization due to lack of vitamin D, rickets and osteoporosis occur ; the calcium blood-level is usually maintained by mobilization of calcium from the bones, but when this mechanism breaks down and the blood-calcium falls below 6 mg. per cent., tetany develops. The daily calcium allowances have been estimated (N.R.C.) as 1·0 g. up to the age of nine years, and 1·3 g. at thirteen to fifteen years. Milk and cheese are rich sources of calcium, and if the equivalent of at least one pint (568 c.c.) of milk a day is included in the diet there is no danger of primary calcium deficiency ; tinned sardines are also rich in calcium.

Phosphorus is not only required for skeletal development, occurring in bone as inorganic phosphorus, but is also widely distributed in the tissue fluids and forms an essential constituent of phospholipids, phosphoproteins, and nucleoproteins. The level of inorganic serum phosphorus shows considerable variation with season and age, being highest in infants exposed to sunlight and receiving vitamin D. In these it may be as high as 7 to 8 mg. per cent., the normal range for infancy being 5 to 6 mg. In older children it falls to 4·5 mg. and in later adolescence to 3 to 4·5 mg. per cent. There is considerable difficulty in estimating the optimum daily intake of phosphorus, since its absorption will be affected by the other constituents of the diet. Phosphorus deficiency will not occur in a mixed diet in which milk is liberally included.

Iodine requirements in infancy are normally provided by milk, and deficiency will only occur in breast-fed infants when the maternal diet is grossly deficient. In certain districts, it has been found that thyroid enlargement is common in older children (*e.g.*, 'Derbyshire neck') owing to an abnormality of the water supply, and here the iodine deficiency can be remedied by the routine use of iodized table-salt.

Vitamin Requirements

The daily allowances recommended by the Committee on Foods and Nutrition, National Research Council, U.S.A., are as follows:—

TABLE 6

Age.	Vitamin A (International units)	Vitamin B_1 (Mg.)	Vitamin C (Mg.)	Riboflavin (Mg.)	Nicotinic Acid. (Mg.)	Vitamin D (I.U.)
Under 1 year .	1,500	0·4	30	0·6	4	400–800
1 to 3 years . .	2,000	0·6	35	0·9	6	—
4 to 6 years . .	2,500	0·8	50	1·2	8	—
7 to 9 years . .	3,500	1·0	60	1·5	10	—
10 to 12 years .	4,500	1·2	75	1·8	12	—
Girls 13 to 15 years	5,000	1·4	80	2·0	14	—
Boys 13 to 15 years	5,000	1·6	90	2·4	16	—

The requirements of vitamin D after the age of one year will depend very largely on the child's exposure to sunlight, since vitamin D is manufactured in the skin in the presence of sunlight. As this factor cannot be accurately assessed, particularly in urban areas where there is a smoke-pall, it may be assumed that the minimum allowances for infants apply throughout early childhood. The British Pædiatric Association (1942) advised 500 to 700 I.U. for infants, whether breast- or bottle-fed, in addition to any supplement given to the mother, a similar daily dosage for older infants, dropping to 3,500 I.U. weekly at school age.

Asher (1945) has made a detailed study of vitamin dosage and of the various preparations available, which should be consulted when proprietary preparations are used; these should bear the vitamin content on the label (Pharmacy and Medicines Act, 1941). Preparations classified as foods must also bear the vitamin content on the label (Labelling of Food Order, 1944).

When vitamins A and D are prescribed in a combined preparation, care should be taken to see that the vitamin D requirements are covered, since this vitamin is less widely distributed in constituents of normal diet than is vitamin A. The requirements of both are covered by 9 c.c. (2 teaspoonfuls) of cod-liver oil (B.P. codex) or by 2½ minims (approximately 5 drops or 0·15 c.c.) of halibut-liver oil (B.P.C.), or by 2 capsules of vitamin A and D liquid (B.P.C.). It should be remembered that the popular cod-liver oil and malt contains only 15 per cent. of cod-liver oil.

It is seldom necessary to prescribe vitamin B_1, riboflavin or nicotinic acid except in treatment, since the requirements are covered by a normal diet.

Synthetic preparations of vitamin C need only be given when natural products (*e.g.*, orange juice or black currant purée) are unavailable or in rare cases where they are not tolerated. The infant's daily needs are covered by 3 to 9 teaspoonfuls of black currant purée (Ministry of Food), the same amount of fresh orange juice, 1 to 3 teaspoonfuls of Government orange juice concentrate, or 1 to 3 teaspoonfuls of rose-hip syrup (B.P.C.).

The value of vitamin K in the prevention of hæmorrhage in the newborn has already been considered (p. 68).

Breast Feeding

It cannot be too strongly emphasized that this is still the ideal method of infant feeding, notwithstanding the great improvements in artificial feeding of the last fifty years. Breast feeding should therefore always be encouraged unless there is some real contra-indication. The familiar arguments in its favour still hold good. Human breast-milk is the food most perfectly adapted to the infant's needs ; it is provided at the optimum temperature, and the risk of contamination is minimal. It has the economic advantage of passing direct from producer to consumer. The incidence of infection and gastro-intestinal upsets is still significantly less in large groups of breast-fed infants as compared with those artificially fed, although the difference has become less marked with a higher standard of artificial feeding. The comfort enjoyed by the infant in contact with a soft breast instead of a hard bottle, and the confidence gained by the mother in supplying the infant's needs herself, are factors in the successful rearing of infants which it is difficult to assess statistically, but which may be assumed to have real importance. Unfortunately many women start with the conviction that they are unable to feed their infants, either because their own mother did not do so, or because a previous attempt was unsuccessful, or because lactation has been established late. It is therefore most desirable that advice and encouragement with regard to breast-feeding should be given during pregnancy, and that any social, economic or physical difficulties which can be overcome at this stage should be recognized early and not left until too late. This is particularly important during a first pregnancy, as successful breast-feeding of a first infant usually means that subsequent infants will also be breast-fed.

Preparation of the Breasts. This should begin during the latter months of pregnancy. The breasts should be bathed at least once a day, and dried with a rough towel. This will tend to improve the circulation, and render the nipples less tender and less liable to crack. The mother should be warned against clothing pressing tightly on the nipples and breasts. A properly fitting support should be worn, particularly by women with heavy breasts ; there is otherwise a danger of the breasts becoming pendulous, with interference with the circulation and lymphatic drainage of the dependent parts. If the nipples are found to be retracted into the surrounding breast-tissue, the surface of the latter should be gently pressed away from the nipple in each direction laterally, and the nipple drawn forward. This procedure must be carried out daily until the retraction is corrected, as otherwise the infant will be unable to take the nipple into his mouth. It is therefore important that the breasts should be examined well before the end of pregnancy, as it is often impossible to correct retraction if it is attempted rapidly after delivery. Rough handling of the breasts, scrubbing the nipples, or the ignorant practice of 'breaking the nipple strings' either before or after delivery, are wholly undesirable and are liable to lead to the formation of breast abscess. Hardening of the nipples with alcohol is likely to produce exactly the condition it is intended to prevent, namely cracking, since it results in loss of elasticity. Waller (1946), in a well-controlled experiment, obtained excellent results by instructing pregnant women in massage of the breasts and expression of secretion during the latter months of pregnancy ; it was found that the subsequent free flow of milk was thus more readily established, with a significant diminution of breast-engorgement, and that 83 per cent. of the instructed mothers successfully breast-fed their infants for six months as compared with 42 per cent. of the control group.

Technique of Feeding. Depending on the condition of the mother, the baby should be put to the breast two or three times during the twenty-four hours after delivery. It will only obtain small amounts of colostrum during this time, but the sucking reflex will be initiated and lactation stimulated.

In establishing the subsequent *régime*, it is essential to bear in mind that the *régime* is intended primarily for the benefit of the baby, secondarily for the benefit of the mother, and only thirdly and lastly for the convenience of the nurse. Amongst primitive peoples, the baby is usually put to the breast when it cries, and, since hunger is the strongest emotion in the young infant, an irregular feeding *régime* is established, based primarily on the demands of the stomach. Of recent years, authorities on infant feeding have tended to go to the opposite extreme, and insist that the baby must only be fed when they think it ought to be hungry rather than when it actually is. Too vigorous attempts to fit the baby to a rigid *régime* rather than to adapt the *régime* to the needs of the individual baby, however, are likely to defeat their own object, and frequently lead to the mother abandoning breast-feeding in despair.

For practical purposes, the *régime* should be regarded as a compromise between the baby's demand to have the breast immediately available when it desires food or comfort, the baby's physiological need of intervals between feeds for sleep, digestion and emptying of the stomach, and the mother's need for rest, exercise, and time for the secretion of a fresh milk supply by the breasts after nursing. From what has already been said, it is seen that there is considerable individual variation in the time in which the stomach empties and hunger-contractions occur in different babies, whilst emotional factors, sleep, and even position may influence their time of appearance in the same baby. It is only reasonable, therefore, that the *régime* should be to some extent flexible, particularly in early infancy. Interesting observations have recently been carried out on babies 'fed on demand' at the breast, in which the time and number of feeds were charted. In the case of twins studied by Trainham *et al.* (1945), it was found that by the seventeenth week both babies had by themselves established a remarkably regular three-feed-a-day schedule, which would appear at least as Spartan as any *régime* normally recommended. Solid food had also been introduced at an early age with exceptionally little difficulty, the babies usually taking a new food after starting nursing, and continuing to nurse after it had been eaten.

In the newborn period, it is most desirable that the baby should be with the mother as much of the time as practicable, and not be deposited in a nursery except at certain fixed 'feeding times.' In the case of babies born in hospital, it is too often the case that the mother returns home without having had any real opportunity of getting to know her baby, or recognizing whether he is crying because he is hungry, or wet, or cold, or troubled with wind, or requires his position changing. This is a common cause of over-anxiety in the mother and of breast-feeding being abandoned immediately after the lying-in period.

For the first ten days the baby can be put to the breast wher it is hungry, which is likely to be about eight times in the twenty-four hours. Except at night (when it is found that a certain proportion of newborn babies can sleep six hours without distress), the infant should not go for more than four hours without being nursed. It is exceptional for full-term babies to require feeding more than eight times in the twenty-four hours after the first week.

When the mother starts getting up, her time and household duties will usually have to be considered as well as the baby, and the feeding schedule gradually regularized. This does not mean, however, that if the infant wakes ravenously hungry at 5·15 a.m. he must be left screaming until his feed is due at 6. This certainly does no good to the baby, and is extremely distressing to the mother, whose milk supply may be affected in consequence.

In the course of the first few weeks it will usually be found that the number of times that the baby sleeps for four hours between feeds gradually increases, and that he can thus slide into a four-hourly feeding programme rather than be forced into it. No hard-and-fast rule can be given as to when the night feed can be omitted, though it is obviously a great advantage to the mother (not to mention the father) when she can get six or more hours undisturbed sleep. The times usually adopted on a 'three-hour programme' are 6 a.m., 9 a.m., 12 noon, 3 p.m., 6 p.m., 9 p.m., 12 midnight and 3 a.m. if necessary; for a four-hour programme, 6 a.m., 10 a.m., 2 p.m., 6 p.m., 10 p.m. and 2 a.m. if necessary. They should, however, be adapted as required, and on the 'three-hourly' programme a feed at 10 p.m. should be substituted for the 9 p.m. and midnight feeds as soon as possible in order to give the mother adequate sleep; on a 'four-hourly' schedule, the 10 p.m. feed should be given at 11 p.m. and the 2 a.m. feed omitted when practicable.

When the baby is nursing seven or eight times in the day, he should be put to one breast only at each feed, the right and left breast being given alternately. When the interval between feeds has reached four hours, both breasts should be given for ten minutes at each feed, the right breast first at one feed and the left breast first at the next. The total time of nursing at each feed should not exceed twenty minutes, as a normally sucking infant will have obtained the greater part of his feed in less than half this time. Prolonged sucking on an empty breast is liable to cause excessive swallowing of air and subsequent discomfort.

Air-swallowing. As already described, the swallowing of a certain amount of air during feeding is a normal occurrence during nursing, and a gas-bubble in the stomach can always be demonstrated radiologically. The baby should be held erect and an opportunity for eructation should always be given after a feed. When both breasts are given at a feed it is usually advisable to hold the baby up for a minute or two when the change-over is made. If the necessity for eructation is forgotten, and the infant laid down immediately after feeding, he is liable to suffer from distension and colic (see p. 79), or the air may be eructated together with regurgitation of some part of the feed.

Position. For the first two weeks after delivery, the mother should be partially recumbent whilst nursing; subsequently she will usually prefer to sit on a low chair with her feet so placed that the arm holding the baby can conveniently be rested on the thigh. It is important that her position should be comfortable, as otherwise frequent changes of position will disturb the infant and will make nursing unnecessarily tiring. If possible, the mother should rest for a short while before each feed. An atmosphere of anxiety and hurry will inevitably react both on the infant and the milk supply, whilst any interference or disturbance by other people is likely to be resented both by the mother and the baby.

The infant should be held in the crook of the mother's elbow, with the head and shoulders raised. It is not uncommon to see both breast- and bottle-fed infants placed horizontally, a position making it difficult for the infant to swallow and liable to result in regurgitation into the nasopharynx. There must be a clear air-way to allow the infant to breathe comfortably whilst sucking. If there is any nasal obstruction, the nose should be gently cleaned with a wisp of cotton wool before feeding, and care should be taken that a pendulous breast is supported with the mother's free hand to prevent it smothering the infant's face.

Composition and Secretion of Breast Milk. Different samples of human milk vary considerably in composition, depending on whether they represent the first or last part of the feed, and on the time of day at which they are taken. Nims *et al.* (1932), studying samples taken at four-hourly intervals from the same woman, found a steep rise in fat content at approximately 10 a.m. which could not be altogether accounted for by activity. The mother's diet, if ill-balanced, and her exposure to sunlight, may also affect the composition of the milk, particularly with regard to iron and vitamin content. The milk drawn from the breast at the end of the feed has a higher fat-content than the 'fore-milk.' The testing of individual samples is therefore apt to be deceptive unless the breast is completely emptied at the time of a feed and a sample taken throughout the twenty-four hours. Average values (Marriott) are :—

Total protein	1·25 per cent.
Fat	4 per cent.
Carbohydrate (lactose) . . .	7 per cent.
Mineral salts	0·19 per cent.

The protein consists of lactalbumen and caseinogen, which are present in the proportions of 0·75 and 0·50 per cent. respectively. The fat-content is the most variable factor (other than total volume), and the carbohydrate-content the least. Human and cow's milk both have a caloric value of approximately 20 calories per fluid ounce (or 70 calories per 100 c.c.). The infant's fluid and caloric requirements will therefore be supplied by 2¼ to 2½ fluid ounces per pound body weight per day (150 c.c. per kilo.). In practice, it is found that many large active babies take more than this amount, and double their birth weight considerably before six months of age.

It is extremely rare that the quality of the mother's milk is really unsuitable for her infant, though babies are frequently weaned on the supposition that this is the case. In cases of difficulty, the fault is much more likely to lie in the quantity of the milk or the technique of feeding. Occasionally it is found that a woman who is on a grossly deficient diet herself is secreting milk which has a deficient iron and vitamin content ; here the remedy lies in the correction of the maternal diet. A few drugs (*e.g.*, bromides) have been shown to be excreted in the milk, and it is generally advised that nursing mothers should not take saline purgatives. There is, however, no basis for the popular belief that green vegetables eaten by the mother cause green stools in the baby. If these possibilities are kept in mind, and local infection of the breast excluded, it can be assumed that the quality of the breast milk is not the cause of feeding difficulty.

Lactation is usually established in from three days to a week after parturition. Before this time the breasts contain a secretion, colostrum, having considerable nutritive value and possibly some anti-infective properties also. It is yellow in colour, and has a relatively high protein content, containing less fat and carbohydrate than the later milk. It should be realized that the change from colostrum to milk secretion is not a sudden and complete process taking place on a particular day ; it is often several days, or even three weeks, before lactation is fully established. Failure to recognize this frequently results in infants being weaned before three weeks of age, on the assumption that the milk supply is inadequate, whereas with patience and temporary complementing of the breast-feeds, nursing could have been carried on successfully.

The supply of breast milk is partly dependent on the demand, and an important, if not the most important, stimulus to secretion is a strongly sucking infant who empties the breast at each feed. Stripping of the breasts manually or by breast-pump at the end of the feeds will often increase the supply when the infant is sucking feebly or when additional breast milk is required for another baby (figs. 16 and 17). As long as the mother's health is good, her milk supply is unlikely to be affected by her build ; many slightly built women are able to breast-feed twins quite successfully.

Similarly, the size of the breast is often deceptive, a small firm breast often giving a larger milk yield than a large pendulous one.

The mother's diet should be liberal and well balanced, containing fresh vegetables, butter, eggs, and the equivalent of 1½ pints of milk per day in fresh milk, ' household milk ' and cheese. The fluid intake should be higher than normal, but there is no advantage in the mother's taking stout, as is often recommended, if she dislikes it, and no indication for consistent overfeeding. Fresh air and a reasonable amount of exercise are most deirable, whilst worry and fatigue are likely to affect the milk supply adversely.

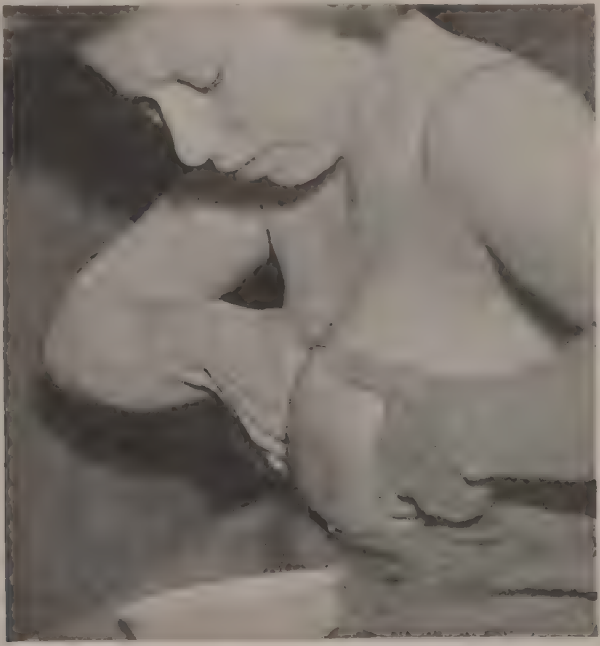

Fig. 16. Manual relief of the breast by the mother ; in this case the milk could only be expressed by pressure applied far back. (From Waller, H., 1946, *Arch. Dis. Childh.*, 21, 1.)

Breasts and nipples should be kept scrupulously clean, and the nipples carefully dried and covered with gauze after each feed. If there is a tendency for them to become cracked or sore, a nipple-shield should be used during nursing until they are completely healed, or the infant fed temporarily on the sound side ; lanoline or Friar's balsam should be applied. If the infant is allowed to continue sucking directly on a cracked nipple, a breast abscess is likely to follow. When this occurs, the infant should be taken completely off the affected breast, and nursed solely on the other. The milk from the affected breast can be expressed manually or by breast-pump, and the infant returned to this breast when the abscess has healed. Similarly, with nipples that are too large for the infant's mouth at birth, it may be worth while expressing breast-milk for some considerable time to see whether the infant can learn to cope with the difficulty.

Sucking on any part of the breast except the nipple is likely to lead to the formation of a painful hæmatoma.

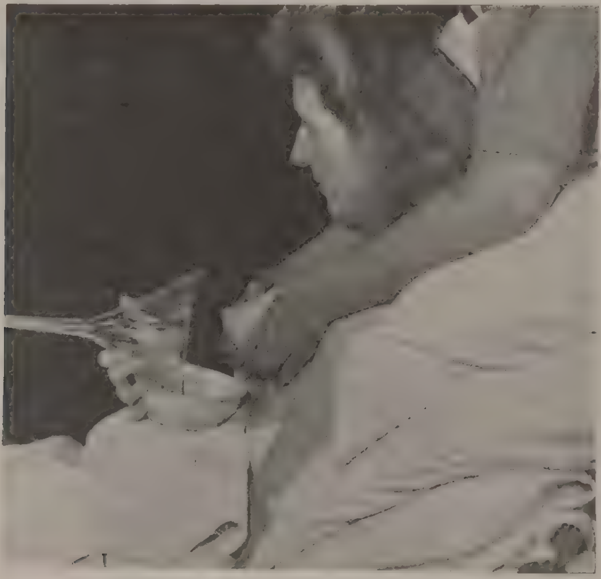

FIG. 17. Relief of high milk tension by a nurse. Thumb and finger are compressing the lacteal sinuses. The funnel is a convenience in collecting the milk. (From Waller, H., 1946, *Arch. Dis. Child.*, 21, 1.)

Test Weighing. When there is doubt as to whether the breast-milk supply is either inadequate or grossly excessive, a series of test feeds can be carried out. The procedure is not recommended when a baby is doing well on the breast and no troubles are being encountered, except possibly to illustrate to an intelligent mother the normal differences in milk intake at different feeds, and the short time in which the greater part of the feed is obtained. The infant is weighed before and after feeding, the difference in weight representing the weight of milk consumed ; it is not necessary to undress the baby, as it is only the difference in weights that is significant ; it follows that a napkin wetted during the feed should not be changed until the baby has been reweighed. Since the amount of breast milk varies considerably at different times of day, usually being highest in the early morning, and lowest at the mid-day and afternoon feeds, it is advisable to average the amount taken at at least three feeds in order to obtain an indication of the daily intake. By this means it is possible to estimate the amount of complementary feeding required when the breast-milk is inadequate.

Difficulties in Breast-feeding. Apart from air-swallowing and abnormalities of the nipple, which have already been referred to, the principal difficulties that arise in breast-feeding are (1) underfeeding, (2) overfeeding, (3) inability of the infant to suck, (4) unwillingness of the infant to suck (' breast-shyness '), (5) disinclination or fear on the part of the mother, and (6) interference on the part of relations.

(1) *Underfeeding* is usually due to an inadequate supply of breast milk, which can be demonstrated by test-feeding. The infant fails to gain weight, and at first goes ravenously to the breast and still appears hungry and restless at the end of a feed. There is excessive air swallowing. In prolonged underfeeding, the infant becomes apathetic, and appetite is diminished rather than increased. Test-weighing will show which feeds are principally inadequate and should be supplemented.

It is unfortunately too often the case that breast-feeding is abandoned completely within the first month owing to failure of lactation ; whilst 80 to 95 per cent. of babies are being breast-fed when they leave hospital or when the midwife ceases to attend about the tenth day, the percentage drops to 50 per cent. by the end of three months. Robinson (1943), in an analysis of 1,100 cases of premature weaning, found that 53 per cent. occurred within the first month, and that in 40 per cent. of these early failures there appeared to be no adequate cause. Waller (1946) regards defective functional capacity of the breast as the major cause of premature weaning, and as already indicated, has made out a strong case for the manual expression of fluid and colostrum from the breast during the last months of pregnancy, with the purpose of establishing a free flow of milk when lactation is established, and avoidance of engorgement of the breast and subsequent ' drying up ' of the milk supply.

It is undoubtedly true that mothers whose milk flows spontaneously from the nipple as the breasts become filled very seldom have any difficulty in successfully breast-feeding their infants. Sore nipples and breast-abscess also occur seldom when there is a free flow of milk and absence of congestion.

(2) *Overfeeding* is shown by, at first, an excessive gain in

weight, followed by failure to gain, regurgitation of increasing amounts of milk after a feed, and finally by frank vomiting. The stools often become loose. The condition is remedied by cutting down the length of time spent on each breast to five or seven minutes for babies on four-hourly feeding, and if this is not sufficient in the case of a strongly-sucking infant, a small amount, *e.g.*, half to one fluid ounce, of water may be given before the feed. In hot weather the infant's need is for increased fluid rather than increased food, and if milk is the only fluid offered it is likely to feed excessively when merely thirsty. Overfeeding is less commonly a cause of ill-health than is underfeeding.

(3) *Inability of the infant to suck* may be due to general feebleness, prematurity, mental defect, or to lesions of the lips and mouth. In the case of an infant who has previously sucked well the mouth should be carefully examined for local lesions, of which thrush is the most common. The ' sucking blisters ' often seen on the lips of young breast-fed infants do not usually cause any disability. It is extremely rare for shortness of the frænum (' tongue-tie ') to be responsible for difficulty in sucking, and the common practice of cutting or tearing the frænum in young infants is wholly unnecessary. It should be remembered that the tip of the tongue grows forward as the infant develops and what may appear to be ' tongue-tie ' is usually a perfectly normal state in early infancy.

(4) *Breast-shyness.* The infant who is both hungry and able to suck but refuses the breast provides a problem requiring both patience and ingenuity for its solution. Painful local lesions of the mouth must of course be excluded. It will then sometimes be found that the infant has a blocked airway or that the nipple is too large or too small for his mouth. In other cases the trouble is due to difficulty in initiating the flow of milk, and here moistening of the nipple with milk may encourage vigorous sucking. Where the milk supply is also inadequate, it is worth while giving a small complementary feed from a bottle tied to the mother's shoulder, from which a soft rubber catheter leads down to the nipple ; in this way the baby, sucking on nipple and catheter at the same time, stimulates secretion and obtains milk whilst doing so.

(5) *Disinclination of the mother to breast-feed* may be due to actual repugnance to the idea of breast-feeding as such, to dislike of an unwanted baby, or to the feeling that breast-feeding will interfere with her normal duties or amusements. Such cases will sometimes respond to tactful management and advice, particularly during pregnancy, whilst the mother who is determined

not to be too closely tied to the baby throughout the whole day will often agree to continuing two or more breast-feeds if artificial feeds are substituted during the times she is most anxious to be free. Such a compromise will often avoid breast-feeding being abandoned altogether. Fear and over-anxiety about breast-feeding can be relieved by tactful supervision, but it is most important that the mother should gain confidence in handling and feeding her baby during the lying-in period.

(6) *Interference by relatives*, who are often well-meaning but misguided, is one of the most potent causes of failure of breast-feeding. There can be no doubt that many grandmothers are actively jealous of their daughter's breast-feeding and so possessing the baby, and though the motivation may not come into consciousness they are only too eager to get the baby off the breast and take over the management of the bottle-feeding. 'My mum said my milk didn't agree with him' is an only too familiar plaint in any welfare clinic.

Constipation and Diarrhœa. In view of the normal variation in the number of stools that different infants pass each day, the stools should be examined before a diagnosis of either constipation or diarrhœa is accepted. If the stool is of normal consistency for age and is passed without difficulty, the fact that stools are infrequent is no indication for medication. Similarly, stools may be small and frequent, but if not abnormally fluid or discoloured there is no cause for alarm. The passage of small 'hunger stools' which are dark in colour is an indication of underfeeding rather than diarrhœa.

When the stool is harder than normal and causes discomfort on defæcation or shows streaks of blood on the outside, the anus should be carefully examined for the presence of a local lesion, and if necessary a rectal examination performed. Simple constipation can usually be overcome by increasing the fluid intake or adding orange juice to the diet ; the simplest natural laxative is one to two teaspoonfuls of stewed prune-juice. In more obstinate cases, milk of magnesia or liquid paraffin are usually effective ; the latter acts as a simple lubricant, but stronger laxatives are inadvisable if they can be avoided. The aim in both infants and older children is to establish a natural and regular bowel action, and not to rely on purgatives. Parents are apt to forget that voluntary control of defæcation should be vested in the child and not in his mother, and there are many children who share the dilemma of the small boy who never knew where his bowels were because his mother was always moving them.

Diarrhœa in the breast-fed infant is usually due to parenteral infection, chilling, or overfeeding, particularly in hot weather. It provides in itself no indication for weaning, though it will be necessary to give additional fluids until the primary cause has been corrected.

Contra-indications to breast-feeding are very few. Maternal diseases such as advanced cardiac disease, insanity, or pulmonary tuberculosis may form absolute contra-indications, though in the case of active pulmonary tuberculosis it should be remembered that the mother is almost as likely to infect the infant if she bottle-feeds it herself as if she breast-feeds it ; in this case, segregation of the infant from birth until the mother's condition is inactive is the only logical procedure. Maternal diabetes was also previously looked on as a contra-indication, but it has been shown that diabetic mothers whose condition is carefully controlled with insulin can often successfully breast-feed their infants without ill-effect. Syphilis acquired by the mother after delivery should be regarded as an absolute contra-indication, but if the infection precedes delivery, the infant will not suffer further harm from nursing from the mother.

Where the milk supply remains inadequate despite careful supervision, and the infant is failing to thrive on complementary or supplementary feeds, breast-feeding may, after careful consideration, have to be abandoned altogether. No hard and fast rule can be given as to how long to persist in attempts to establish satisfactory lactation, but a point comes at which the baby is being sacrificed to the breast, and when the experienced advocate of breast-feeding will know it is in the best interests of the baby to admit defeat.

Complementary and Supplementary Feeds. A complementary feed is an artificial feed given immediately after a breast-feed when the breast milk supply is inadequate for the infant's requirement. A supplementary feed is an artificial feed completely replacing one of the breast feeds. Complementary feeding should be looked on as a temporary measure designed to tide over a period of deficient lactation, *e.g.*, when lactation is established late or when the mother is temporarily overtired or debilitated. By complementing the feeds, it is possible to maintain the milk supply by giving regular stimulation to the breasts, and also to supply the infant's needs ; the complement is reduced as the breast milk increases in amount. It is essential to give the artificial feed after the infant has been put to the breast and not before, as otherwise he will not suck vigorously on the breast or will refuse it altogether.

Supplementary feeds are given when the mother's health or occupation necessitate the omission of one or more breast-feeds. Thus a working mother may be able to breast-feed at night and in the morning but not at middle day, whilst one who wishes to be free in the evening may be willing to nurse during the rest of the day.

Vitamin Supplements. Although breast-fed infants are considerably less likely to suffer from vitamin deficiencies than are artificially-fed infants, it is a wise precaution in the case of urban babies particularly to give orange juice and vitamin D after the third month (see p. 88).

Weaning. Weaning is much facilitated if small amounts of different foods, such as cereal, bone and vegetable broth, egg yolk, cod-liver oil and orange juice, have already been introduced at an early age (three to four months). Crusts or rusks should be given for the infant to chew at five months, though little will be actually eaten until the teeth have erupted. The length of time that breast-feeding should be continued will depend to some extent on the condition of the mother, but from the point of view of the baby it is usually found in practice that it is considerably easier to start weaning at six months, when the baby is showing new interest in putting outside objects into his mouth, than if it is left to nine or ten months. From the nutritional point of view, it should be remembered that whilst there is no harm in the baby having drinks of breast-milk throughout the second year (as is a common practice in primitive communities and where no clean milk supply is available), milk is inadequate as the sole source of iron after six to eight months, and there is a real danger of nutritional anæmia occurring if breast-feeding is continued too long.

Weaning should not be begun if the baby is ill or during very hot weather, but for the normal infant a practical policy is gradually to drop one breast-feed during the seventh month, and subsequently one breast-feed each week until the baby is off the breast by the ninth month. At this age the baby can digest whole cow's milk (either boiled or pasteurized liquid milk, or full-strength dried milk) and soft solids (cereal, egg, potato, sieved green vegetables, apple sauce, and small amounts of mince). The reaction to a new taste is often a negative one, and the baby should be offered new foods, with a chance of indulging preferences, rather than being forced to eat them.

Some valuable studies on self-selected diets during the toddler period have been carried out by Davis (1928) and others, in which infants of the weaning age were allowed to eat what they chose out of a reasonably large selection of foods. It was found that they not only throve on this *régime*, but that the diets they selected were adequate in quantity and practically optimal in composition.

Artificial Feeding of Infants

Practically all the standard methods of artificial feeding of infants are based on the use of cow's milk, and since the digestive system of the young infant is perfectly adapted to the digestion of breast-milk but not to that of cow's milk, some modification of the latter is necessary. If the composition of human and cow's milk is compared, it is seen that not only does human milk have a higher carbohydrate value, but that the total and relative proportions of the milk-proteins are different :—

TABLE 7

	Human milk.	Cow's milk.
Caloric value (per fluid ounce)	20	18–20
(per 100 c.c.)	70	70
Carbohydrate (lactose) per cent.	7	4·75
Fat	3·5–4	3·75
Total protein	1·25	3·4
Lactalbumin	0·75	0·4
Caseinogen	0·5	3·0
Total minerals	0·2	0·73

Unmodified cow's milk forms a larger and tougher curd than human milk, and the buffering action is three times as great (see above). In fact, the percentage of fat and the caloric value are the only two factors which correspond closely on average analysis, and both of these are variable in individual samples.

The curd of cow's milk can be modified and rendered more digestible in a great variety of ways, *e.g.*, dilution, boiling, evaporation, drying, or by the addition of sodium citrate or lactic acid, and all these processes have been employed in infant feeding. It is not intended to give more than an indication of the methods that are found satisfactory, or of the types of proprietary foods that are normally available, since a great many unnecessary complications have been introduced in a misguided attempt to make infant feeding an exact science. These for the most part have defeated their own object, since the infant is not a test-tube nor the working-class kitchen a laboratory.

Calorie Feeding. This is based on the calculation of infant's daily caloric requirements, which are approximately 45 to 50 calories per pound body weight, or 100 calories per kilo. If liquid cow's milk is used, having a caloric value of approximately 20 calories to the fluid ounce or 70 calories per 100 c.c.,[1] the caloric requirements of older infants who are able to digest undiluted milk would be covered by a daily intake of $2\frac{1}{4}$ to $2\frac{1}{2}$ fluid oz. per pound body weight, or 150 c.c. per kilo, supposing that the infant was at this time receiving nothing but milk. In the case of younger infants, however, the milk will require dilution ; the caloric value of the feed is then made up by the addition of carbohydrate in the form of sugar (cane sugar or dextrimaltose being most commonly used) having a caloric value of 120 calories per oz. (*i.e.*, 1 oz. sugar has the same caloric value as 6 fluid oz. milk) or 4 calories per g. It is known that the infant's protein requirements will be covered by the amount of protein contained in $1\frac{1}{2}$ fluid oz. milk per lb. body weight, and its fluid requirements by a total of $2\frac{1}{4}$ to $2\frac{1}{2}$ oz. of fluid per lb. body weight per day. If then we take the example of a 10 lb. baby, the formula is calculated as follows :—

The total caloric requirements will be 450 calories (45 per lb.).

Of these, $1\frac{1}{2}$ fluid oz. milk per lb. = 15 oz. will provide 300 calories.

The additional 150 calories (*i.e.*, 450 — 300) will be provided by $1\frac{1}{4}$ oz. of sugar. The total fluid requirements ($10 \times 2\frac{1}{4}$ or $2\frac{1}{2}$ oz.) will be met by the addition of $7\frac{1}{2}$ to 10 fluid oz. of water. We then have :—

Cow's milk, 15 fluid oz. = 300 calories
Sugar, $1\frac{1}{4}$ oz. = 150 ,,
Water, $7\frac{1}{2}$ fluid oz.

Total, $22\frac{1}{2}$ fluid oz. = 450 ,,

Since the infant will be fed five times in the day, this total is divided into five feeds, each of $4\frac{1}{2}$ fluid oz., consisting of 3 oz. milk, $1\frac{1}{2}$ oz. water, and 2 drachms sugar, and representing 90 calories.

Using the metric system and approximate equivalents, we may reckon that the infant's caloric requirements will be 100 calories per kilo body weight per day, its fluid requirements 150 c.c. per kilo body weight per day, and its protein requirements will be

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[1] The variation in the composition, and particularly the fat content, of cow's milk introduces considerable errors into any routine system of caloric feeding. Thus Jersey milk, with a fat content of over 5 per cent., will have a higher caloric value than the figures quoted, whilst the values for milks lower in fat are as follows :—

3·5 per cent. fat . . .	18 calories per fluid oz., or 62 per 100 g.
3·0 per cent. fat . . .	16 ,, ,, ,, ,, ,, 57 ,, ,,
2·5 per cent. fat . . .	15 ,, ,, ,, ,, ,, 53 ,, ,,
Skimmed milk . . .	10 ,, ,, ,, ,, ,, 34 ,, ,,

covered by 100 c.c. milk per kilo body weight per day. Taking the example of a 5 kilo baby needing 500 calories daily :—

500 c.c. (*i.e.*, 100 c.c. per kilo) of milk will provide 350 calories. A further 150 calories will be required (total 500–350) and this will be provided by 38 g. sugar (150 ÷ 4).

Fluid requirements will be made up by the addition of 250 c.c. water (thus giving a total of 5 × 150 c.c. = 750 c.c.).

The formula for the complete day will then be :—

Milk, 500 c.c. = 350 calories
Sugar, 38 g. = 150 ,,
Water, 250 c.c.

Total, 750 c.c. = 500 ,,

Divided into five feeds, each feed will represent 150 c.c. mixture providing 100 calories, and consist of 100 c.c. milk, 50 c.c. water, and 7·5 g. sugar.

Since the equivalents are only approximations, it will be seen that whereas in the first example the added carbohydrate represents exactly one-third of the total calories, in the second it represents slightly less. As a general rule, the former proportion should not be exceeded after the first few weeks of life. The total calories in the two examples are of course different, since a 5 kilo baby weighs 11 lb.

Where an unsweetened condensed milk, or a full-cream dried unsweetened milk is used, the calculation of calorie feeding is similar after an appropriate amount of water has been added to the condensed milk or powder to reconstitute what is virtually liquid cow's milk (see below). In these cases, however, the cow's milk curd has already been rendered more digestible and a more concentrated feed can be given if desired.

Principles of Dilution of Liquid Milk. In both the examples given, it will be seen that the formula contains two parts of milk to one part of water. This is not a fixed proportion, since the infant's fluid requirements will vary with temperature and its capacity for digesting cow's milk curd will increase with age. During the first few days of life, the infant may be started with a dilution of 1 part of milk to 4 parts of water ; this can usually be strengthened to equal parts of milk and water by the end of the first five days, and reach a dilution of 2 parts milk to 1 part water by the end of the first month. (A useful stock mixture is 12 oz. cow's milk, 6 oz. water, 1 oz. sugar, this having a caloric value of 20 calories per fluid oz. The amount of the mixture to be given is calculated on the infant's caloric requirements for weight.) Unless the milk is modified by the addition of sodium citrate or lactic acid, the dilution remains approximately the same until the fourth or fifth month, when the proportion of water is gradually decreased. At six months of age, most infants can tolerate undiluted cow's milk. It is no longer necessary to add carbohydrate, as additional foods (cereal, apple sauce, soup, etc.) should be introduced at or before this time. In preparing a liquid milk formula it is advisable to bring the mixture to the boil in a double saucepan even if it is known that the milk has previously been pasteurized.

In hot weather and during pyrexial illness, the dilutions of the feeds should be increased or additional fluid given between feeds.

Condensed and Dried Milk Feeding. Although everyone concerned with infant feeding should be familiar with the use of liquid cow's milk, an increasing number of artificially fed infants are reared on dried or condensed milk. Dried milk has certain great advantages where refrigerators are rare and ice-men practically unknown. It is received sterile, it can be kept clean in a closed tin for a reasonable length of time, it is economical (since only the amount required for each feed need be taken from the container), and it is easily transported. Normally, a great many proprietary brands are on the market, and the manufacturers' literature must be consulted for the individual composition. The majority of these are manufactured so that one drachm by weight of powder made up to one fluid ounce with water will form one ounce of reconstituted milk or ' modified milk mixture ' having the caloric value of whole milk. Since the specific gravity of the various brands varies, a scoop which contains one drachm by weight is sometimes provided by the manufacturers. (If the metric system is used, the proportions are 100 g. of powder made up to 800 c.c. with water, or *pro rata* amounts).

Unsweetened full-cream condensed milk is also a satisfactory basis for infant feeding, and has some of the advantages of dried milk. It must, however, be used promptly after the tin has been opened.

The processes of manufacture of both dried and condensed milks are considered in Chapter XX, and only their applications to infant feeding will be referred to here. The great popularity of proprietary dried milks is due to their being designed so that, when reconstituted as directed, they provide a feed for infants of different ages with little or no further modification. The manufacturers also obligingly indicate the suggested quantities on the tin.

The following are the more important types of dried and condensed milks in general use :—

(1) '*Humanized*' *Dried Milks.* In these the percentage composition of the dried milk is so modified that when the milk is reconstituted by addition of the appropriate amount of water, it has the approximate composition of breast-milk. Thus the percentage of carbohydrate is raised and an adjustment effected in the relative proportions of caseinogen and lactalbumin. An example is Humanized Trufood. These milks are suitable for the feeding of young infants without further modification.

(2) '*Modified*' *Dried Milks.* A large number of modified dried milks are normally available, of which the essential feature is that the fat-content of the reconstituted milk is reduced to 2 per cent. and carbohydrate content raised to give a caloric value of 20 calories per fluid ounce of reconstituted milk ; the total protein content may be reduced to 2 or 2·5 per cent. These milks are suitable for the feeding of infants up to three months of age, usually without further modification. They are sometimes described as 'modified half-cream' milks, owing to the reduction of fat-content. Many are reinforced with vitamin concentrates.

(3) *Dried partly skimmed milk* (¾ or ½ or ¼ cream) is unmodified except for the drying and removal of a proportion of the cream. The tin must be labelled 'Should not be used for babies except under medical advice.' These dried milks have a certain value in infant feeding, since although the caloric value of the reconstituted milk is reduced below 20 per fluid oz., it may be desirable in particular cases, *e.g.*, following diarrhœa, to give an infant milk in which both the fat and carbohydrate content is low ; carbohydrate can then be added gradually as desired.

In the case of 'Dried Machine-skimmed Milk' (or 'Dried Skimmed Milk'), the tin must be labelled 'Unfit for babies,' since the caloric value of the reconstituted milk is too low for routine use in infant feeding. Again, such milk may be valuable for a short period whilst the infant is recovering from a digestive upset, or in such conditions as cœliac disease where there is failure in absorption of fat.

(4) *Dried Full-cream Milk* when reconstituted represents whole cow's milk, and since the toughness of the curd is modified by the drying process is suitable for feeding normal infants over three months of age. Many proprietary brands are fortified by the addition of vitamin supplements.

(5) *Condensed Full-cream Milk, Unsweetened,* is cow's milk which has been heated to reduce the volume to half or one-third of that of the original milk. When reconstituted by the addition of the

appropriate amount of water it can be used in the same way as whole cow's milk, and has similar advantages in modifying the toughness of the curd as dried full-cream milk.

(6) *Condensed Machine-skimmed Milk, Unsweetened*, is similarly processed after removal of the fat, and must be sold as 'Unfit for Babies.' The same observations apply to its use as to dried skimmed milk.

(7) *Condensed Full-cream Milk, Sweetened*, although popular, is most unsuitable for the routine feeding of infants owing to its high carbohydrate content. It may sometimes be indicated in the feeding of small and feeble infants when it is desired to give a high caloric intake over a short period, but its extreme sweetness will often make a change to other feeding more difficult. If used over a long period it is likely to result in a fat, flabby infant with a low resistance to infection and a tendency to rickets.

In addition to the above types of dried and condensed milks, there are a number of proprietary brands designed specifically for premature, anæmic, or sick infants. Lactic acid milk, either dried or freshly prepared from liquid milk, has had considerable popularity in the feeding of both normal and sick infants, owing to the fact that it can be used in a more concentrated form than unmodified milk. When prepared from liquid milk, 60 minims of lactic acid are added a drop at a time with continual stirring to one Imperial pint of milk in the cold. (This proportion corresponds to 45 minims to one American pint.) Whey is still sometimes used temporarily in the feeding of sick infants, but is unnecessary in normal infant feeding. It contains minimal quantities of fat and less than 1 per cent. of protein.

General Principles of Artificial Feeding of Infants

To summarize the general principles of artificial feeding of infants :—

(1) A feed with a high fat content is not well tolerated in early infancy, and it is advisable to use a half-cream (or diluted) feed for the first three to four months.

(2) The curd of cow's milk, being tougher and less readily digestible than that of human milk, requires modification (by dilution, evaporation or drying) for infants during the first five to six months.

(3) Added carbohydrate should not represent more than approximately one-third of the total calories of the feed.

(4) If the feed is adjusted to an approximate caloric value of 20 calories to the fluid ounce (70 calories per 100 c.c.), it will satisfy the infant's caloric requirements in a volume which

corresponds with the normal fluid requirements; if more dilute fomulæ are used, the infant may not tolerate the increased volume of the feeds. Dried or evaporated milk is therefore often preferred for the feeding of infants under three months of age.

(5) The feed should be warmed to approximately body temperature.

(6) The same general principles of establishment of *régime* by study of the individual baby rather than by a rule-of-thumb three- or four-hourly schedule apply as in the case of breast-feeding, as do those of position and eructation of swallowed air. A baby should never be fed lying flat on its back, or left to feed itself with the bottle attached to the pillow, as milk is liable to enter the Eustachian tubes and result in otitis media.

(7) The teat of the bottle should be suitable for the baby's mouth, *i.e.*, of a size and consistency such that the baby can take it well back into the mouth, and suck vigorously on it.

(8) The hole in the teat should be large enough for the milk to flow out drop by drop when the bottle is inverted. (This can usually be adjusted by passing a red-hot darning needle through the hole if it is too small).

(9) It should be remembered that the risk of infection is greater in artificially fed infants than in those who are breast-fed, and bottles and teats should therefore be carefully washed and scalded after each feed, and kept scrupulously clean. Two types of bottle are in general use. The Soxhlet bottle is flat-bottomed, and can be stood upright in a rack, which is convenient when the day's feeds are sterilized together as is usually done in institutions. As air has to pass into the bottle through the teat to prevent the formation of a vacuum, the teat should be removed from time to time from the baby's mouth during the feed. The boat-shaped bottle has a valve fitted at the opposite end from the teat, so that air can enter during sucking, and has the advantage that when the valve is removed it can more easily be washed.

(10) During the seventh month the infant should begin to learn to drink milk from a cup or spoon. The same general principles of weaning and introduction of solid foods apply as in breast-feeding, but it is even more important that iron-containing foods should form a substantial part of the diet during the second six months.

(11) Vitamin supplements are essential in artificial feeding, and although some of the proprietary brands of modified dried milk contain added vitamins, these should not be relied on. Vitamin C in the form of orange juice, tomato juice, black-currant purée or extract of rose-hips should be introduced in small quantity at

three months and increased to two teaspoonfuls three times a day by six months. Orange juice is well liked by most infants, and its introduction presents little difficulty. It should be continued throughout the third year. It should be remembered that vitamin C is destroyed rapidly by heat in the presence of air, and even by standing at room temperature, so that if fresh orange juice is used it should be freshly prepared each time it is given. Hot water should never be added. Vitamins A and D are contained in cod-liver oil and halibut-liver oil, and various vitaminized oils are available (Asher, 1945). Cod-liver oil emulsion has a less fishy taste than the pure oil, and is therefore usually preferred, but it must be remembered that the emulsion is less potent than the pure oil. A few drops should be introduced at three months (or earlier in the case of prematures), and gradually increased until the infant is taking two to three teaspoonfuls of the pure oil or six to nine teaspoonfuls of emulsion daily at six months. Both vitamins must be continued during the second year, and longer if the infant is not getting regular exposure to sun. In those cases where fat is badly tolerated, a concentrated oil (*e.g.*, halibut-liver oil) can be used. Six drops daily of most of the standard preparations cover the requirements for vitamins A and D (see p. 88).

The above supplements represent rather more than the theoretical requirements, and allow for the inevitable small wastage.

(12) Whilst the theoretical caloric requirements of the infant should be known by anyone responsible for infant feeding, no rigid system of caloric feeding can serve as a substitute for common sense. The main advantages of such methods are that they help to guard against under-feeding and an ill-balanced diet, but there are bound to be differences between individual babies and between the same baby's requirements at different times.

Diet for Older Children

Menus calculated on dietetic requirements and food values are neither necessary nor desirable for older children, except when large numbers have to be catered for in institutions. The appetite factor is all-important, and if the older child has developed healthy feeding habits he will amply cover his requirements from the average middle and upper working-class house diet. In the case of children from poorer homes, the factor most likely to be deficient is protein, since first-class protein (contained in meat and cheese) is one of the more expensive items. Here the diet tends to consist too exclusively of carbohydrate. The general provision of milk and school meals should go a long way to remedy the defect, though here again the previous failure to establish good feeding habits and appetite may defeat the intention. Le Gros Clarke (1942, 1943) carried out investigations on the schoolchild's reaction to school meals and tastes in vegetables, and found that when no persuasion was exerted, greens were refused by over 50 per cent. of girls aged five to ten, and by 44 per cent. of girls aged ten to thirteen; the percentage of boys in the same age groups was significantly lower.

Milk is particularly valuable during childhood and adolescence, since it not only provides animal protein but is also one of the richest sources of calcium. A certain amount of discrimination must be used, however, in the time of day that drinks of liquid milk are given. Many children do not tolerate fat in large amount, and if milk is drunken shortly before the main meal it may reduce appetite.

It is generally recommended that children up to five years of age should consume a pint of milk a day (including that used in cooking), and after this age at least $\frac{3}{4}$ to $\frac{1}{2}$ pint daily throughout the growth period if other first-class protein and calcium-containing foods are included in the diet. When younger children are unwilling to take this amount, the consumption of animal protein can be made up with cheese, lean bacon, or mince, according to preference. A common mistake is to give small children too much as a first helping, and to be shocked when it is not all eaten. First helpings should be small, and second helpings allowed as desired.

For infants during the weaning period, vegetables should be sieved. Subsequently a reasonable amount of roughage in the diet is useful in maintaining regular bowel action, since too small a stool will tend to result in constipation. Sufficient roughage is assured by the regular inclusion of green vegetables and fruit in the diet.

It is still only too common to find a weekly purge included in the working-class diet. This is wholly unnecessary, and tends to produce exactly the condition it is intended to avoid. If the child is costive, liquid paraffin is harmless and acts as a simple lubricant, but usually increased fluid intake, regular exercise, and fruit will achieve the desired result. It is most important that the child should have time for a regular bowel action, as constipation is often found to be due to the only lavatory being required by several children simultaneously before they leave for school.

The following specimen diets and menus (designed during the war by the Ministry of Food) are satisfactory, but should not be regarded as in any way rigid; choice and variety are almost as important as palatable cooking, and the child has to explore the gastronomic world as he does the social and spiritual.

R. W. B. Ellis.

SUGGESTED DIETS FOR CHILDREN FROM ONE TO TWELVE YEARS (MINISTRY OF FOOD)

(In each diet, one food from each of the sections (*a*), (*b*), (*c*), (*d*), etc. below should be served at each meal.)

DIET FROM ONE TO TWO YEARS

On Waking

Concentrated orange juice (3 teaspoonfuls diluted with water).

Breakfast 8.0—8.30 a.m.

(*a*) Whole-grain cereal: ½ breakfast cup porridge, or groats, or wheatmealies,[1] or 1–2 rusks with milk.
(*b*) Half an egg (4 days a week), or ½ rasher of crisp bacon (1 day a week), or ½ small slice of crisp bacon toast (1 day a week) or 2 level tablespoons steamed fish (1 day a week).
(*c*) Milk, ⅓ pint.

Dinner 12.0—12.30 p.m.

(*a*) 4 tablespoons vegetable broth or soup (4 days a week).
(*b*) Meat, fish, cheese or egg:—1—3 level tablespoons of: roast or boiled mutton or beef, or stewed minced steak, or chicken, or stewed tripe with 4 tablespoons milk, or lightly cooked liver, or steamed white fish, or herring roe, or eggs, or cheese (1 level tablespoon).
(*c*) Cooked fresh vegetables:—1—3 level tablespoons of sieved finely chopped or mashed: spinach or cabbage or greens, or carrot, or turnip, or cauliflower, or skinned tomato.
(*d*) Potatoes:—1—3 level tablespoons:—boiled, or mashed, or jacket.
(*e*) Pudding:—2–4 tablespoons of: milk pudding, or junket with sieved stewed fruit or jelly jam, or custard blancmange with sieved stewed fruit, or jelly jam, or baked apple and milk or custard, or chocolate mould, or hot custard over rusks and jam, or fruit fool, or light sponge pudding.
(*f*) 1 hard rusk, plain, or sweetened with custard, or flavoured with cocoa.
(*g*) Water to drink.

Tea 4.30—5.0 p.m.

(*a*) Bread:—½–1 slice, or 1 rusk, or 1 oatcake with:—
(*b*) Butter, or margarine, or dripping, and:—

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[1] Wheatmealies: 6 slices stale bread, ⅜ in. thick. Cut into ¼-in. squares. Put on a baking sheet and bake in a slow oven till brown and crisp. Store in a tin. Serve 1 to 2 tablespoons with milk and sugar to taste.

(*c*) 1 level teaspoon seedless jam, or jelly, or honey, or ¼ level teaspoon vegetable extract, or 1 level dessertspoon finely shredded raw cabbage, or finely grated raw carrot, or chopped parsley, or cheese.

(*d*) Milk, or milky cocoa, ⅓ pint.

NOTE.—Start salad or vegetable sandwich at 18 months. A biscuit may be given in place of rusk or bread and jam.

Cod-Liver Oil

This should be taken regularly (as indicated above).

MENU FOR ONE TO TWO YEARS

Breakfast

1st day. Rusk and milk ; coddled egg and toasted breadcrumbs ; milk.
2nd day. Porridge and milk ; crisp fried bacon ; toast ; milk.
3rd day. Groats and milk ; creamed fish (fresh or canned) and rusk ; milk.
4th day. Wheatmealies and milk ; lightly boiled egg and toasted breadcrumbs ; milk.
5th day. Porridge and milk ; toast and crisp bacon ; milk.
6th day. Wheatmealies and milk ; lightly boiled egg ; milk.
7th day. Rusks and milk ; coddled egg and toasted breadcrumbs ; milk.

Dinner

1st day. Chopped roast mutton ; sieved cabbage and mashed potato ; vegetable broth ; chocolate mould or fruit fool ; sweet rusk.
2nd day. Grated cheese ; grated raw carrot ; mashed cauliflower and jacket potato ; junket and sieved stewed fruit (or jelly jam) ; chocolate rusk.
3rd day. Minced liver, or stewed mutton ; mashed swedes and chopped parsley, and boiled potato ; vegetable soup ; milk pudding ; sweet rusk.
4th day. Fish, or chopped stewed tripe with milk ; mashed carrots and parsley and mashed potato ; baked apple or prune purée ; and sweet rusk.
5th day. Minced or scraped steak ; sieved greens, and boiled potatoes ; vegetable broth ; padded pudding, or rusk trifle ; sweet rusk.
6th day. Creamed herring roe, or creamed salmon ; tomato pulp (or sieved sprouts, or spring greens), and jacket potatoes ; creamed milk pudding ; chocolate rusk.
7th day. Grated cheese ; sieved spinach or greens, and mashed potatoes ; vegetable soup ; chocolate mould ; sweet rusk.

Tea

1st day. Parsley spread sandwich, rusk and jelly jam, milk.
2nd day. Oatcake and butter, cheese spread sandwich, milk.
3rd day. Bread, butter and jelly jam, toast and dripping, milk.

4th day. Spinach sandwich, rusk and syrup, milk.
5th day. Carrot and parsley sandwich, oatcake (or rusk) and jelly jam, milk.
6th day. Toast and butter, carrot and parsley sandwich, milk.
7th day. Savoury rusk and butter, carrot and parsley sandwich. milk.

DIET FROM TWO TO FIVE YEARS

On waking

Concentrated orange juice (3 teaspoonfuls diluted with water).

Breakfast 8—8.30 a.m.

(*a*) Whole-grain cereal, 2–4 tablespoons porridge, or groats, or wheat-mealies or 1–2 rusks with milk.
(*b*) ½ to 1 egg (2 mornings), or bacon—½ to 1 rasher (4 mornings), or fish or herring roe (1 morning).
(*c*) Bread :—1–2 slices as : dry toast, or hard rusk, or crisp fried bread with :
(*d*) ½–2 teaspoons butter, or margarine, or dripping, or bacon fat.
(*e*) Milk :—¼ pint.

Mid-Morning Meal 10—11 a.m.

Milk—1 cup (¼ pint).

Dinner 12.30—1 p.m.

(*a*) Meat, fish, cheese or egg, etc. :—1–1½ tablespoons of roast mutton or beef (minced or finely cut up), or stewed minced steak, or chopped liver, or 1 egg or ½–1 tablespoon cheese, or fish or herring roes, or brains, sweetbread, chicken or rabbit.
(*b*) Cooked fresh vegetables :—1–2 heaped tablespoons of mashed greens, or cabbage, or cauliflower, or spinach, or sprouts, or swedes, or turnips, or carrots, or peas, or beans.
(*c*) Potatoes :—1–2 heaped tablespoons of mashed, or boiled, or jacket.
(*d*) Puddings :—2–3 tablespoons of milk pudding, or junket, or blanc-mange, or stewed fruit and custard, or fruit fool, or egg custard, or 1–2 tablespoons of light steamed or baked pudding.
(*e*) Rusk :—one.
(*f*) Water to drink.

Tea 4.30—5.0 p.m.

(*a*) Bread :—1–2 whole slices as : dry toast, or plain or sweet rusk or dry slices, or sandwiches with :
(*b*) ½–2 teaspoons butter, or margarine, or dripping and :
(*c*) Jam, or jelly, or honey, or vegetable extract.
(*d*) Grated raw carrot and finely shredded raw salad or green vegetables.
(*e*) Milky cocoa—1 large cup.

MENU FOR TWO TO FIVE YEARS

Breakfast 8—8.30 a.m.

1st day. Porridge and milk ; lightly boiled fresh egg, or scrambled dried egg ; toast and butter ; milk.

2nd day. Wheatmealies and milk ; bacon ; dry toast and bacon fat ; milk.
3rd day. Groats and milk ; coddled fresh egg, or scrambled dried egg ; rusk and butter ; milk.
4th day. Rusk and milk ; bacon with crisp fried bacon toast ; milk.
5th day. Porridge and milk ; bacon ; rusk and bacon fat ; milk.
6th day. Wheatmealies and milk ; creamed herring roes, toast and butter ; milk.
7th day. Rusk and milk ; bacon ; rusk and butter ; milk.

Dinner 12.30—1 p.m.

1st day. Roast meat ; cabbage and mashed potato ; chocolate cream or fruit fool ; sweet rusk.
2nd day. Grated cheese and raw grated carrot ; cauliflower and jacket potatoes ; baked sponge pudding and stewed fruit (or jelly jam) ; rusk.
3rd day. Creamed liver or dried egg omelette ; mashed swede and chopped parsley and boiled potato ; milk pudding ; chocolate rusk.
4th day. Fish or cheese savoury ; mashed parsley carrots and mashed potato ; baked apple or prune purée and custard or junket ; sweet rusk.
5th day. Mince ; greens and boiled potatoes ; padded pudding or rusk trifle ; chocolate rusk.
6th day. Scrambled dried eggs ; tomato (or sprouts or spring greens) and jacket potato ; creamed milk pudding ; sweet rusk.
7th day. Cheese potato or rabbit stew ; spinach and mashed potato ; baked custard ; chocolate rusk.

Tea 4.30—5 p.m.

1st day. Parsley and cheese sandwich ; rusk and jelly jam ; milk.
2nd day. Oatcake (or rusk) and butter ; sprouts sandwich ; milk.
3rd day. Bread and watercress sandwich ; toast and dripping ; milk.
4th day. Spinach and cheese sandwich ; rusk and parsley honey or syrup ; milk.
5th day. Sprout and vegetable yeast extract sandwich ; oatcake (or rusk) and jelly jam ; milk.
6th day. Dry toast and butter ; cheese and cabbage sandwich ; milk.
7th day. Parsley sandwich ; rusk and butter ; milk.

DIET FROM FIVE TO TWELVE YEARS

Breakfast 8—8.30 a.m.

(*a*) Whole-grain cereal ; $\frac{1}{2}$–1 cupful of porridge, or wheatflakes, or wheatmealies, or stewed fruit (in hot weather) with milk.
(*b*) Egg fresh or dried (twice a week), or fried bacon (four times a week), or fish (once a week, herrings, fresh or tinned, if possible).
(*c*) Bread ; 1–2 slices as : dry toast or hard rusk with :—
(*d*) Butter 2–3 teaspoons, or margarine, or dripping, or bacon fat.
(*e*) Milky cocoa.

Mid-Morning 10–11 a.m.
Milk—$\frac{1}{3}$ pint (at school).

Dinner 12.30–1.0 p.m.
(*a*) Meat, fish or cheese, etc. ; 1½–3 tablespoons roast beef (underdone), or mutton, or minced or stewed steak, or liver or kidney, or brains, or sweetbread, or chicken, or rabbit, or fish, or cheese (1–2 tablespoons), or one egg.
(*b*) Cooked fresh vegetables ; 2–3 heaped tablespoons of cabbage, or greens, or cauliflower, or spinach, or sprouts, or swedes, or parsnips, or carrots, or fresh peas or beans.
(*c*) Potatoes ; 2–3 heaped tablespoons mashed, or boiled, or jacket.
(*d*) Pudding ; 3–4 tablespoons of milk pudding, or junket, or blancmange, or light steamed or baked pudding and custard, or stewed fruit and custard, or fruit fool, or other plain light pudding.
(*e*) Rusk ; one, for 3–7 years ; extra potato for 7–12 years.
(*f*) Water to drink.

Note.—Dried peas, beans or lentils should be added to the meat, fish or cheese portion if a full serving cannot be obtained through rationing or shortage.

Tea–Supper 4.30—5.30 p.m.
(*a*) Bread ; 2–4 whole slices as : dry toast, or plain or sweet rusks, or dry slices, or sandwich with :—
(*b*) Butter ; 2–3 teaspoons, or margarine, or dripping.
(*c*) Jam, or jelly, or honey, or syrup, or vegetable extract, or stewed fruit, or canned fish.
(*d*) Raw salad, or shredded raw vegetables (*see* recipes).
(*e*) Milky cocoa, or milk vegetable soup.

Note. At 9–10 years give a light tea as above at 4.30 p.m. and a supper at 6,30 p.m. of one of the following :—Either thick vegetable soup with dry toast and butter ; or vegetable dish with cooked fresh vegetables ; or cheese, herring or sardine with salad and bread and butter.

MENU FOR FIVE TO TWELVE YEARS

Breakfast
1st day. Porridge and milk ; boiled egg ; toast and butter ; cocoa.
2nd day. Wheatmealies and milk ; bacon and mashed potato ; toast and butter ; cocoa.
3rd day. Porridge and milk ; fish cakes ; rusks and butter ; cocoa.
4th day. Wheatmealies and milk ; bacon and fried bread ; toast and butter ; cocoa.
5th day. Porridge and milk ; bacon and baked potato balls ; toast and butter, cocoa.
6th day. Wheatmealies and milk ; scrambled dried egg ; toast and butter ; cocoa.
7th day. Porridge and milk ; bacon and dried bread ; rusk and butter ; cocoa.

Dinner

1st day. Roast joint; cabbage and mashed potato; chocolate mould, or fruit fool; rusk or extra potato.
2nd day. Shepherds pie; cauliflower or greens and jacket potatoes; baked sponge pudding with stewed fruit or jam; rusk or extra potato.
3rd day. Braised liver, or creamed salmon and spinach; mashed swedes, chopped parsley and boiled potatoes; milk pudding; rusk or extra potato.
4th day. Fish or cheese savoury; carrots, and parsley and mashed potatoes; baked apple or stewed fruit and custard or junket; rusk or extra potato.
5th day. Mince; greens and boiled potatoes; cake trifle; rusk or extra potato.
6th day. Mutton hot-pot; tomatoes or sprouts, or spring greens and jacket potatoes; creamed milk pudding; rusk or extra potato.
7th day. Stewed rabbit or brown stew; spinach, and mashed potato; steamed chocolate duff; rusk or extra potato.

Tea

1st day. Parsley sandwiches, sweet rusks, cocoa or tea.
2nd day. Toast and butter, carrot and parsley sandwiches, cocoa or tea.
3rd day. Bread and butter, and watercress, sweet rusk, cocoa or tea.
4th day. Spinach and cheese sandwiches, toast and jam, cocoa or tea.
5th day. Carrot, parsley and vegetable yeast extract sandwiches, sweet rusks, cocoa or tea.
6th day. Toast and butter, cheese and cabbage sandwiches, sweet rusks, cocoa or tea.
7th day. Carrot and parsley sandwiches, sweet rusks, cocoa or tea.

Supper

1st day. Vegetables in cheese sauce, toast, cocoa.
2nd day. Pilchard salad, bread and butter, cocoa.
3rd day. Potato and watercress soup, toast and butter, and cheese.
4th day. Haricot beans and carrots on toast, cocoa.
5th day. Cheese jacket potatoes, and salad, bread and butter, cocoa.
6th day. Lentil and parsley soup, toast and butter.
7th day. Sardine supper snack, toast and butter, cocoa.

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CHAPTER V

THE ESTABLISHMENT OF FEEDING HABITS

As indicated in the preceding chapter, the establishment of proper feeding habits is not sufficiently guaranteed either by knowledge of the working of the infant's digestive tract, or by the right information about its nutritional requirements. To be successful a feeding *régime* has to leave room for the willing co-operation of the infant for whose benefit it has been established. Where the persons responsible for the feeding *régime* fail in winning the child's co-operation, they are defeating their own object and may be harming instead of helping the infant's attitude to food ; at this early phase of life, this attitude to food is of paramount importance in the processes of physical and psychological development.

The intake of food satisfies the earliest and most urgent need of the child's body, its hunger, and thereby constitutes the first gratification of instinct which the child experiences. An infant who feeds successfully is a contented and happy infant. The adult, by providing the necessary nourishment, provides pleasure for the child. It is an established fact in modern child psychology that infants make their first emotional contacts with the people who feed them, since these adults are instrumental in introducing them to experiences of wish-fulfilment, contentment and happiness.

The child's craving to obtain nourishment, to appease its hunger and thereby to gain pleasure, luckily coincides with the mother's wish to safeguard the child's survival and growth by feeding it. So far child and environment are in perfect harmony. The child's hunger, or (as the psychological representative of this bodily need) its appetite, is the securest foundation and the most powerful ally for every feeding *régime*.

On the other hand, we have to take into consideration that the feeding *régime* constitutes on the part of the outside world the first serious interference with an instinctive desire of the child. Pædiatricians and, taught by them, trained nurses and mothers, know what type and form of feeding is wholesome for the child's body. The much debated question of breast or bottle feeding, of the best time for the introduction of supplementary foods, the problems of weaning, the balancing of solids and liquids in the toddler's diet, the balance between carbohydrates, proteins and fats in the older children's meals are decided by them on the basis of scientific findings. Uneducated mothers, who lack information of this nature, and are frequently unwilling to accept the advice of welfare clinics, are nevertheless guided by a feeding code of their own, usually handed down to them by their own mothers, and no less definite with regard to the respective evaluation of meat and vegetables, sweet or savoury foodstuffs, soups and teas, as well as about the times when nourishment should be given or refused. Whether the actual feeding *régime* is the result of scientific knowledge, or of a body of preconceived, out-dated and frequently superstitious ideas, the child finds itself in either case confronted by a more or less rigid set of rules and regulations which, though they are directed towards the same ultimate aim as its own hunger, are only too frequently in direct opposition to the expressions of its appetite.

Mothers, nurses and doctors often seem to act on a tacit agreement that the child's hunger is a blind driving force which cannot be trusted ; that, left to their own devices, children of any age would choose their foods not according to nutritional value but on the basis of ulterior and secondary reasons ; that without continual direction and supervision they would either overeat or starve, ruin their stomachs and their teeth and fail to assimilate enough of the important and body-building substances. In short, the child's hunger is taken to be an instinct without the discrimination and self-regulation which are essential factors in the parallel feeding situations of young animals. The feeding *régime* is meant to correct these defaults and direct the child's appetite into the proper channels.

It is not possible for any individual mother, nurse or doctor to test the truth or fallacy of this assumption under the conventional feeding conditions as they exist in the average family, nursery or hospital. An instinct which, like the child's hunger, is decisively interfered with from the beginning of life, loses any innate ability for self-direction and self-regulation which it may possess and may acquire the very elements of untrustworthiness, lack of balance, and direction which are ascribed to it. Recent studies on these lines, on the other hand, made under completely changed feeding conditions do not confirm the common distrust in the self-regulating powers of the child's appetite. Davis (1928, 1930), a pædiatrician in Chicago, has made a widely known experiment in which she allowed fifteen infants of weaning age to choose what they ate from a wide variety of simple natural foods. The nutritional results were excellent. The children equalled or surpassed the usual standards of growth, were exceptionally free from digestive troubles, never constipated, and presented no feeding problems. She repeated the same experience in another experiment with children ranging in age from pre-school to adolescent in an orthopædic ward in a hospital. The same result was obtained again with three nursing infants who were given their choice of four formulas throughout the nursing period. Davis successfully demonstrated in this manner, not that a child can be entirely depended upon to select its own food under ordinary circumstances (especially after first having had occasion to form very definite likes and dislikes); but that infants and children have a far greater capacity for self-regulation of feeding than is usually recognized. They can be allowed to make their choice among selected foods rich in the nutritional elements essential to growth, and to eat quantities which they themselves choose, without urging, interference, or limitation. Under these conditions they will have better appetites, eat more, and have happier mealtimes than children fed in the usual manner. The pleasure which they obtain from the gratification of their appetite will be fully maintained and form an essential element in the smooth functioning of the feeding process.[1]

Until experiments of this kind are repeated on a wider scale and until their results have gained more widespread recognition, the majority of children will be expected to adapt themselves to feeding *régimes* which reckon neither with the urgency and variability of infantile instinctive needs nor with the compelling power of pleasurable experiences. The first clashes between child and environment usually occur about the intervals and quantities of feeds. Faced with the inexperience or unreliability of many young mothers, many pædiatricians still advocate a too rigid routine for infant feeding, not suggesting that the mothers should deviate from fixed hours even in the face of urgent hunger signals from the child. The average length of time needed for the emptying of the infant's stomach, and the average quantity of food needed at each meal in the various stages of infancy can be accurately assessed, and provide the basis for a feeding scheme. But within this frame-work, the infant's appetite varies in strength according to a whole series of factors such as the variations in physical well-being, duration or depth of sleep, changes or upsets in routine and emotional experiences; the infant's wish for food with the accompanying sensations of comfort and contentment may (due to emotional factors) appear at moments when, in the opinion of the 'environment,' no objective cause for hunger exists. If the child is made to wait too long for its feeds, or if on such occasions the wish for the food remains altogether ungratified, it experiences pain instead of pleasure and learns to associate painful sensations with the subject of feeding. The same happens when infants are too strictly limited in the quantity of their feeds so that the element of contentment is lacking, or when they are forced to eat at moments when they do not feel hungry and reject the food. On all these occasions they experience sensations of a disagreeable and painful nature which may in time outweigh the pleasurable feeding experiences and ultimately spoil the child's attitude to the whole feeding process.

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[1] The author can confirm these findings from personal experience with toddlers in an experimental day nursery in Vienna, 1937–38, and a residential war nursery in London, 1940–45.

Adults are apt to judge the working of the child's appetite on the basis of the corresponding processes in their own organism. For the average adult so long as he is not in a state of ravenous hunger, owing to long deprivation or excessive bodily exertion, it is not difficult to wait for a meal. In infantile life, instincts function differently. The urgency of the instinctive desire, the impatience for its fulfilment, and the discomfort when satisfaction is delayed, are overwhelming. Toddlers who are made to wait for their meal will, due to these conditions, feel intense distress which alters their positive attitude to the food and prevents them from enjoying the meal when it finally arrives. Where the feeding of young children is regulated without regard to such factors, the process of eating may become entirely divorced from the original powerful urge for satisfaction which characterizes every instinctive drive. And when this connection is once lost, meal-times, instead of representing wish-fulfilments, become drab and tiresome tasks for the child, a kind of forced labour.

Considerate handling of the infant's and child's daily feedings, with a reasonable amount of self-determination and self-selection, will prove helpful in safeguarding the child's appetite and will do away with much of the day-to-day struggle about meals which exists in many families. But the consideration of these factors in themselves will not be sufficient to exclude the upsets of feeding habits which arise on all those points where the child's instinctive wish to eat is complicated by the interaction with other instinctive tendencies. Such points of danger are: the child's relationship to the mother who feeds it; the action of the component instincts of infantile sexuality; and the action of the child's destructive and aggressive tendencies.

The Influence of the Mother-Relationship on Feeding. During the first year the infant has no direct access to food and is completely dependent on the mother (or mother-substitute) for the satisfaction of its hunger. The mother is the connecting link between the infant and its food; the wish for the food is, on the other hand, the first reason for the emotional attachment of the infant to the mother.

The infant begins life as a purely egoistic and self-centred being. It finds the way to normal emotional contact with the environment by attaching its first feelings of love to the people who give it the pleasure and comfort connected with the early feeding experiences. The union between feeding and loving which is established at this period will be dissolved again in later childhood. When children have once acquired the ability to love people besides themselves they form their attachments on the basis of other needs and considerations. This does not alter the fact that all human love begins as 'stomach love' and that the latter attitude to food continues to be influenced to some degree by the emotional tie to the mother with which it was inseparably bound up in the beginning.

The *rôle* of the mother-relationship for the establishment of good feeding habits has in recent years found increasing recognition where breast-feeding by the mother is concerned. For the infant who is breast-fed by the mother, food and the mother are truly identical; the attitude to both rests on the same firm foundation of pleasurable experience. The satisfaction derived from feeding and the satisfaction derived from the first emotional attachment merge into one and thereby strengthen and support each other. What is with a common phrase called the child's 'security' is probably based on this double gratification. It is less widely recognized that also the bottle-fed baby attaches its emotions to the people who feed it though its corresponding pleasurable experiences may be less vivid and therefore less binding.

The early identity of love for food and love for the mother leaves its imprint on the reaction to food and may become upsetting to the child's feeding habits. The child shows every inclination to treat food given by the mother as it treats the mother, which means that all the possible disturbances of the child-mother relationship may enter into the feeding situation. The child will in the course of its development experience many negative, jealous and resentful feelings against the mother. Whenever such feelings arise they may easily be displaced to food. When the child fights against the mother and rejects her, it may fight against the food which she offers and which has become a symbol for her attentions. A child may thus be in excellent health, have vigorous hunger, a perfect digestion, a well-developed taste for the right kind of food, and still eat badly. A bad mother-relationship may put a good appetite out of action.

The mother-relationship may act adversely on feeding, not only through its negative side, but through the very intensity of the positive attachment. The child's love for the mother is known to include crude and passionate elements which play a central part in infantile sex life. As this infantile sex life is frustrated by the prohibitions set up against it, the child struggles against these feelings and finally overcomes and represses them after violent emotional upheavals. Where food and the mother figure are too closely connected, much of this battle may be fought out over mealtimes.

It is not possible to exclude difficulties of this nature from a feeding scheme, though much can be done either to increase or to lessen their influence. Mothers should be advised to give the child as much and as early direct access to food as possible ; not to give children the impression that they eat 'for their sake' and not to treat the refusal of food as if the child were refusing and rejecting their love. Whatever they do, the symbolic connection between mother-love and food will remain active in the child's unconscious mind. But the sensible unemotional treatment of this situation by the mother will give the child a better chance to develop beyond this particular phase of its emotions.

With very young children the feeding difficulties of this origin usually disappear when mother and child are separated. Bad eaters of this type eat well when away from home, in day nurseries, in hospital, during temporary absence of the mother. At later stages the difficulty may be so firmly established that in the absence of the mother it transfers itself automatically to every available mother-substitute.

Eating disturbances of this type disappear after puberty when the adolescent normally solves and overcomes his emotional dependence on the parents. Where this fails to happen, the eating difficulty will vanish for some time and then return in the form of psychosomatic symptoms attached to the stomach and digestive tract.

The Oral Pleasures and their Influence on Feeding. From the beginning of the suckling period the infant derives from the milk flow two different kinds of satisfaction : one from the appeasement of hunger, the other from the stimulation of the mouth which is the first of the body zones to produce pleasurable sensations of a sexual nature for the child. The infant experiences this oral satisfaction as an accompaniment to the satisfaction of feeding and reproduces it for itself, independent of the feeding situation, in the various forms of thumb-sucking.

Thumb-sucking is usually taken as a sign that the infant is hungry and comforts itself with a substitute in the absence of the desired satisfaction through food. This is true at certain times. At other moments thumb-sucking is pursued for its own sake as a genuine and independent form of auto-erotic oral gratification.

Oral pleasure as an accompaniment to the pleasure of feeding is further gained from the taste and consistency of the various food substances and plays its highly important part in the formation of the various individual likes and dislikes for food, such as preference for sweets or salty foods, or for hot or cold fluids.

The normal oral pleasures of the child should not be interfered with. Where thumb-sucking, or a craving for sweets, is treated with harshness, the child may turn against its orality, repress the manifestations of it and thereby seriously damage its positive attitude to feeding in which they are an essential element.

The Aggressive Instinct and its Influence on Feeding. Eating for the young child has a further significance which may give rise to serious disturbances of the feeding *régime*. To eat symbolizes an aggressive action against the food which is in this way attacked and consumed or against the person who is represented by the food.[1] Every toddler passes through a stage when biting plays a large *rôle* as the most important expression of his aggressions against the outside world. This happens at the time when biting and chewing solid food becomes very important in the child's feeding.

When these oral phantasies become repressed, the consequences are felt in feeding. The child develops inhibitions against eating, and may refuse to bite, to chew, or to swallow its food.

Normally, these difficulties disappear when the early oral tendencies are overcome and controlled by the child. Where this development fails, *i.e.*, when repression is not successful, the child remains anxious about his oral aggressions and this may affect the pleasure in eating during the whole of childhood. Many children are quite unable to eat whatever reminds them of the destruction of a living creature; they hate to see in their food any recognizable bodily part or shape of an animal; they remember for ever with violent revolt the finding of a partly hatched chicken in an egg; they are shocked at the idea of eating an animal which they have known alive; and some other children are very glad to take refuge in vegetarianism to escape from these conflicts.

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[1] See in this connection Melanie Klein and her school on the significance of oral-aggressive phantasies for early childhood.

In extreme instances an eating inhibition of this type may lead to actual starvation. Such a development, which is luckily rare, signifies that the individual cannot tolerate this oral aggression in himself and has turned the aggression against his own body which is thereby seriously threatened, or even destroyed.

The Anal Tendencies and their Influence on Feeding. All young toddlers use the food substances with which they come in contact for another pleasurable purpose besides eating. They enjoy playing with their food, as a pleasant substance to handle, to smear with, etc. This behaviour is not accidental and not to be explained by the clumsiness of their age. The children use the foodstuffs at their disposal deliberately for the purposes of play and, in playing with them, use their hands and their fingers very cleverly and skilfully. This smearing with foodstuffs does not differ from the smearing with excrements in which all young toddlers indulge, or would like to indulge, if they were given the opportunity.

When habit-training has taken effect, the children change their behaviour in this respect. Instead of revelling in dirt, many become uncomfortable when brought in contact with it; some become anxious when their fingers are dirty or sticky, hold out their hands to be cleaned, etc. Substances which delighted the child a short while ago become objects of disgust.

No toddler becomes reliably clean without passing through a phase during which disgust and fear of dirty matter is overemphasized. This development leads to unwelcome consequences in feeding, since disgust goes over to the foods which by their sight, touch or smell remind the child of anal matters. At this period many toddlers refuse all foods of squashy or smeary consistency; many are revolted by all courses which are either brown or green; some acquire the habit of liking their food dry, without gravy or custard.

These food fads are at their peak between the second and third year when the child's anal repressions and his defences against a return of dirty habits are in the process of being established. They diminish when this part of the child's development has been completed. Some individuals retain certain violent dislikes and avoidances of special foods throughout life; but the majority of foods are, after an interval, re-admitted into the child's diet.

It should be kept in mind that feeding disturbances of this kind are not due to any direct handling of the feeding situation but the by-product of habit-training. Where habit-training is carried out early and forcibly, the repercussions on feeding are all the greater; where the child is given more time to become clean, messy eating will persist longer but feeding will be less disturbed by the consequences of anal repressions.

No useful purpose is served by forcing children to eat foods against which they have formed a temporary violent dislike.

The question arises as to how wise it is to interfere with the eating methods of the toddler directly, *i.e.*, to force table manners on the child who is still content to enjoy his messiness. Where this is done, all pleasure in the spontaneous handling of the food is cut out and the toddler's interest and pleasure in the meal is thereby diminished. Children who are brought up in this way do acquire good table manners earlier than others ; but there is no doubt that they lose some of their appetite in the process.

To achieve the best feeding results, small toddlers should be given freedom to deal with their food as they like. They will acquire their table manners indirectly, as their habit-training and their general cleanliness progresses, when their growing skill in handling implements will then be put to its proper use. Children of three will then easily be well-mannered enough to join a nursery school table, to serve themselves and others, to pour from jugs and keep their tables clean. At the age of four or five they will be well able to manage knife and fork in a civilized manner.

Other Emotional Elements and their Influence on the Feeding Situation. The symbolic significance of eating plays a big *rôle* in the older child's phantasy life. At the height of infantile sex development every child tries to observe and understand the parents' sex life. Many children form the belief that what goes on between the parents at night has something to do with the mouth. Some believe that the parents breathe into each other's mouth to produce a baby ; others that the father feeds the mother with something and that the baby grows out of the food. (See some of the best-known fairy tales in this connection.) Some children believe that babies are born through the mouth.

Phantasies of this kind become repressed from the child's consciousness, and from the unconscious give rise to various eating inhibitions. Children may refuse to eat so as not to get 'fat.' Many children have a horror of fat people which to them represent the mother in her pregnancy. Other children develop the idea that their food will poison them ; being poisoned has for them the symbolical meaning of being impregnated.

The common promise that good eating will make the child 'big and strong' has the opposite from the desired effect on some children. Due to feelings of guilt towards their parents, they want to remain 'small' and thereby to escape many imaginary dangers, among them the danger of dying. They refuse food, and endanger their health, in the service of this anxiety.

Neurotic eating inhibitions of this type may disappear spontaneously when the phantasies which cause them lose importance and are superseded by others. Where they persist, nothing will be of any help against them except the uncovering and mastering of the anxieties themselves.

A. Freud.

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CHAPTER VI

DEVELOPMENT AND CARE OF THE TEETH

The human dentition is omnivorous in character. The period of development of both deciduous and permanent teeth extends over a period of just over two decades. The deciduous teeth, which start to calcify during the fourth month of intra-uterine life, provide a complete dentition of twenty teeth between approximately the third and sixth year of life. From then onwards they are gradually replaced by successional permanent teeth while at extended intervals permanent molar teeth appear at the posterior ends of the dental arches.

Embryology

A depression, seen at the twelfth day of gestation between the forebrain vesicle above and the prominence arising from the formation of the visceral arches behind, is the first indication of the primitive mouth. Here the surface ectoderm lies in apposition with the entoderm of the foregut. With the disappearance of these superimposed layers at the third week the stomodæum communicates with the foregut.

As the forebrain prominence folds downwards in front of the primitive mouth the fronto-nasal process appears from its ventral wall and grows downwards and forwards. The process differentiates into two medial and two lateral nasal processes.

From the sides of the first visceral arch the mandibular and maxillary processes grow ventrally (fig. 18). Between the fifth

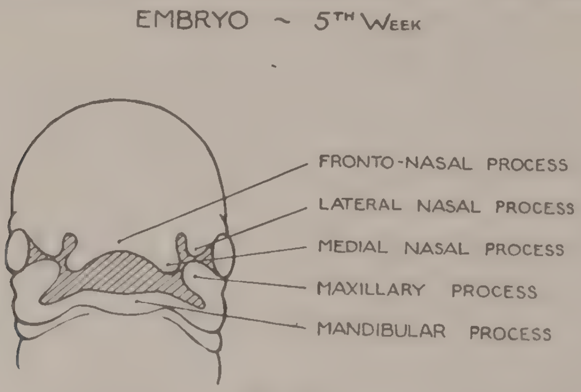

Fig. 18.

and eighth week the processes bordering the stomodæum fuse, and at the eleventh week the latter is separated from the nasal cavity by the union of the maxillary palatal processes and medial and lateral processes in its roof.

The teeth have their origin in a differentiation of the ectoderm at the margins of the primitive mouth. At the sixth week a continuous lamina, known as the dental lamina, is formed; this increases in vertical depth and, by virtue of an upward growth of surrounding tissues, the band appears as an ingrowth from the surface. There is one for the maxillary and one for the mandibular teeth.

On the medial side of the dental lamina proliferation takes place in the regions where the future deciduous teeth are formed. The localized thickenings produce enamel organs. Beneath each enamel organ develops a dental papilla from mesodermic tissue which rises and invaginates the organ until the latter becomes bell-shaped. The mesoderm from the base of the papilla multiplies and finally encircles the whole invaginated organ to form the dental follicle (fig. 19). Aberrations of the dental formative organs give rise to odontomes.

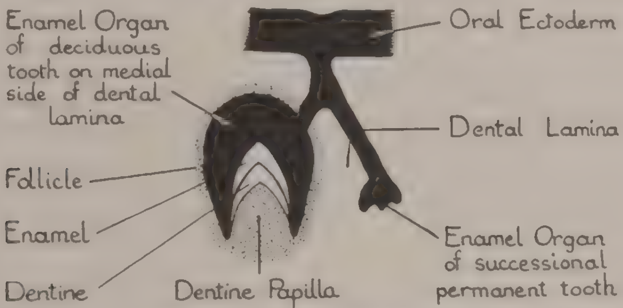
Enamel Organ of deciduous tooth on medial side of dental lamina
Oral Ectoderm
Dental Lamina
Follicle
Enamel
Dentine
Dentine Papilla
Enamel Organ of successional permanent tooth

FIG. 19. Diagrammatic representation of section of developing tooth.

The first indication of the permanent teeth which will replace the deciduous dentition is the appearance of enamel organs adjacent to the deciduous tooth follicles and branching from the medial side of the dental lamina near its deeper free end. The enamel organs of the permanent molars, which have no predecessors, develop from the distal ends of the lamina.

Derivation of Main Dental Structures

The enamel organ forms the thin hard layer of *enamel* covering the surface of the crown of the tooth, and apparently governs the contour of the crown. Its remains, after the enamel has been formed, give rise to *Nasmyth's membrane*, a thin keratinized layer covering the newly erupted tooth which rapidly wears away with mastication.

The dental papilla forms *dentine*, of which the bulk of the tooth is comprised, and finally diminishes in size to become the *pulp* which continues to nourish the dentine throughout the life of the tooth.

From the follicle the *cementum*, a thin layer covering the root, is derived. It also gives rise to the *periodontal membrane* which joins the cementum to the bony socket.

Calcification. Calcification of the deciduous teeth starts at the fourth month *in utero* and is completed during the fourth year of life. Its onset can be demonstrated histologically a little earlier than is revealed by X-rays. Calcification of the permanent teeth is almost wholly a postnatal process, though the first permanent molars start a month before birth. The crowns of all the teeth are completed by thirteen to fourteen years, but entire calcification is not finished until about the twentieth year.

Structure

Enamel. Enamel is the hardest of animal substances. Microscopically it presents a pattern of closely packed ‘ prisms ’ or rods passing in a tortuous manner from the outer surface inwards towards the dentine. Each prism is ensheathed in a thin cuticle of organic material. A densely calcified interprismatic substance exists between the ensheathed prisms. The outcropping of the prisms at the surface of the crown leads to a fine striation running transversely to the long axis of the tooth. The transverse blemishes sometimes seen on the crowns of incisors and first permanent molars are the result of the outcropping in irregularly calcified areas.

Enamel has a water content of 2 to 3 per cent. and there is approximately 4 per cent. of organic matter. The rest is made up of inorganic salts, calcium phosphate approximately (90 per cent.), carbonate and fluoride, magnesium phosphate and small amounts of other salts. Quantitative analyses vary considerably.

Dentine. Dentine has a higher organic content than enamel and its microscopical anatomy is different. It has an organic matrix permeated by a series of branching tubes whose main trunks run in parallel from the surface of the dental pulp outwards towards the border of the enamel or the cementum. Within the tubes is a soft fibril, a prolongation of the substance of the peripheral cells of the dental pulp, which serves a trophic function. The organic content is between 20 and 30 per cent. The inorganic portion contains similar salts to those of the enamel, but there is no similar prismatic structure. When acted upon by acids the organic basis retains the form of calcified dentine, but becomes soft and elastic.

Pulp. The pulp maintains the nutrition of the dentine throughout life. It contains blood vessels, lymphatics and nerves which enter through small foramina at the apex of the root. Innervation is by the fifth cranial nerve.

Cementum. The cementum is not unlike bone and its growth continues slowly throughout life. It has a lamellar structure concentric with the pulp. Canaliculi from the lacunal cells in the lamellæ communicate with one another and on its inner surface with dentinal tubes. Cementum is attached to the periodontal membrane by means of white connective tissue fibres from the periodontal membrane. The fibres pass in through the whole thickness of cementum and in places become calcified.

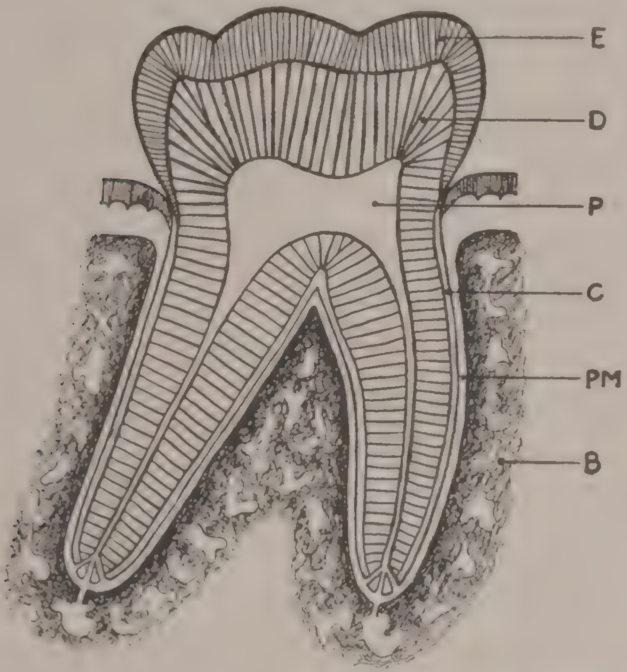

FIG. 20. Diagrammatic representation of section of a molar tooth. E, enamel. D, dentine, forming the greatest mass of the tooth. C, cementum, a thin layer covering the roots. P, pulp, the small foramina at the apices of the roots permitting continuity with vascular nervous system. PM, periodontal membrane, a thin membrane between the roots and the bony socket, B.

Periodontal Membrane. The periodontal membrane which surrounds the root serves to attach the cementum to the bony socket. Its white connective tissue fibres pass both into the cementum and the surrounding bone, suspend the tooth within the socket, and permit slight movement. The membrane is highly vascular and richly supplies with nerves and lymphatics.

Morphology

If a newborn infant's head is magnified to twice its natural size the height from vertex to chin roughly equals the height of the adult head, but the proportions are different. The distance between the fronto-nasal suture and chin must more than double itself to reach adult proportions. The relative increase in antero-posterior depth of the face, though considerable, is less than the increase in height. The increase in width is less still. The profile becomes more prognathous. It is estimated that in bulk the face equals about one-eigth of the skull of the newborn, whereas it is about one-half of the adult skull. The change in these proportions is brought about in a considerable degree by structures which serve the purpose of mastication.

At birth the follicles of the developing deciduous teeth lie in a trough of alveolar bone. They impart a segmented appearance to the overlying gums. The upper and lower gum pads are not in apposition (see fig. 27). The tongue occupies the space between them.

Maxilla. The upper gum pads are barely raised, being almost on a level with the palate. The frænum joins the upper lip to the gum in the mid-line. With the eruption of the teeth and downgrowth of alveolar bone the attachment of the frænum to the gum recedes to a position higher up on the labial aspect of the alveolar process.

The deciduous incisors at birth are beneath the floor of the nose and the canines are at the base of the frontal processes of the maxillæ. The molars are beneath the lower border of the orbits, the antra being represented merely as yet by small furrows on the lateral walls of the nasal cavity.

The antrum enlarges as the body of the maxilla grows downwards, forwards and outwards. The cheek teeth become separated from the orbit. Later still the space occupied by the developing permanent cheek teeth is replaced by the growing antrum as they themselves erupt. The downward growth of the teeth and antrum contributes to the increase in height of the palate. The outward spread of the body of the maxilla provides a broadening base for the dental arch. The increasing depth anteroposteriorly of the maxilla creates room for the successively erupting permanent molar teeth and carries the dental arch forwards.

The zygomatic process at birth is just above and lateral to the site of the developing second deciduous molar. In the adult it is similarly related to the first permanent molars. This cutting back of the zygomatic process by surface modelling accompanies the emergence of the upper jaw.

The length antero-posteriorly of the palate is increased by addition to the posterior border of the palate bone, by growth at the transverse palato-maxillary suture, and the premaxillo-maxillary suture, and to surface addition to the front of the maxilla. Suture growth is slight.

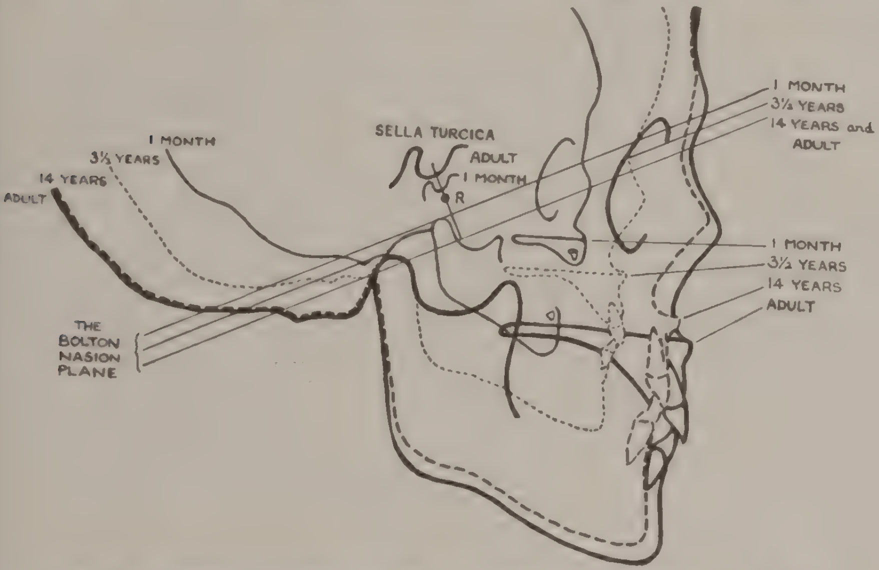

FIG. 21. Broadbent-Bolton Chart. Growth pattern of jaws. Superimposed tracings of X-rays related on the Bolton-nasion plane and registration point (R). Bolton plane cuts the highest point in the profile of the notches at the posterior end of the condyles of the occipital bone, and the nasion. Nasion, frontonasal suture in the median sagittal plane. Registration point is midway on a perpendicular from the Bolton plane to the centre of the sella turcica. (After Broadbent, B. H., 1931, *Angle Orthodontist*, **1**, 45, and 1937, *Ibid.*, **7**, 209. See also Saltzmann, J. A., 1943, *loc. cit.*).

Mandible. The mandible at birth is little more than a gutter of bone containing the follicles of the teeth. The condyle is nearly at the same level as the superior border of the horizontal ramus. At the symphysis there is fibrous union during the first year. As growth proceeds bone is deposited at the upper border and on the outer surface of the body of the mandible, and on the superior and posterior surface of the ascending ramus. The site of greatest activity is beneath the condyle whereby the mandible is moved in a downward and forward direction.

The pattern of growth of the jaws and teeth has been demonstrated by Broadbent. Taking advantage of the fact that relatively little growth changes occur at the base of the cranium he orientated serial X-rays of the growing head (fig. 21). By superimposing tracings of these X-rays he was able to show that the general direction of growth of the upper teeth is downwards, forwards and outwards. In the mandible teeth move upwards, forwards and outwards, though since the horizontal ramus travels forwards and downwards in relation to the cranial base the upward movement of the lower teeth is masked. Normally anatomical landmarks travel along straight lines. The path of the incisors moves downwards and forwards. The posterior end of the palate moves directly downwards, and the angle of the mandible downwards and slightly backwards. Where the teeth are crowded and irregular it is commonly found that the forward adjustment of the whole facial mass is retarded.

Eruption

The tooth follicle migrates occlusally at all stages of its development and such movement bears no direct relation to the lengthening to the root. An interval of approximately a month separates the time from when a deciduous incisor appears to the time its crown has erupted. The molars take two to three times as long. The gums may be swollen and congested over the site of an erupting tooth.

There is considerable variation in the times of eruption of the deciduous teeth. All twenty should have erupted by three years. In each jaw there are four incisors, two canines and four molars. The order and times of eruption are approximately :—

Deciduous dentition		Date of eruption
Central incisors	lower upper	8th month
Lateral incisors	upper lower	10th ,,
First molars		12th ,,
Canines		18th ,,
Second molars		24th ,,

The roots are not fully formed until approximately two years after eruption.

The arch of the upper teeth is larger than that of the lower. The upper anterior teeth and the buccal cusps of the upper cheek teeth articulate externally to the lower teeth. At first all the teeth are spaced. The relationship in the antero-posterior plane of the lower to the upper arch is such that the distal surfaces of the upper and lower second molars normally lie on a plane at right angles to the plane of occlusion. This early occlusal relationship is not normally maintained. The lower arch moves forward slightly more rapidly than the upper arch, and before the shedding of the deciduous molars, the earlier spacing of which has by then disappeared, the distal surface of the lower second molar is medial to that of the upper second molar (fig. 22).

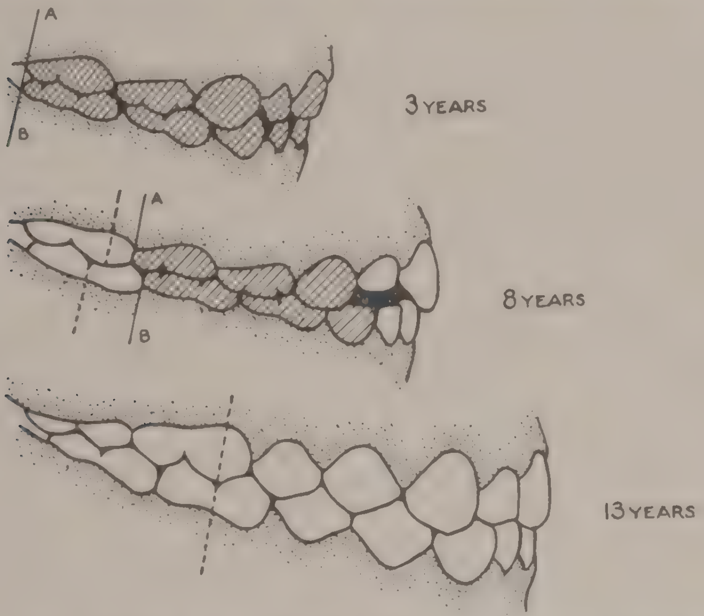

FIG. 22. Changes in the occlusal relationship between upper and lower teeth.

Both arches broaden, the upper more than the lower. The relative increase in the breadth of the upper arch prevents an upset of the occlusal relationship of the cheek teeth in the lateral plane as the lower arch moves forward. Comparatively inconspicuous errors in antero-posterior relationship tend to lead to more obvious malocclusion of the permanent teeth. Normally all teeth slowly show signs of attrition from mastication. Deciduous incisors usually become more spaced before they are shed. The time of shedding is up to about six months prior to the eruption of the replacing teeth. Girls tend both to complete eruption and to shed their teeth earlier than boys.

Permanent Dentition

There are sixteen permanent teeth in each jaw, comprising four incisors, two canines, four pre-molars and six molars. The ten permanent teeth anterior to the molars in each jaw succeed the deciduous dentition. Eruption is unaccompanied by local or general disturbances.

The order and times of eruption are approximately :—

Permanent dentition		Date of eruption
First molars	lower	6th year
	upper	6½th ,,
Central incisors	lower	6–7th ,,
	upper	
Lateral incisors	lower	7–8th ,,
	upper	8–9th ,,
First pre-molars	upper	10th year
Canines	lower	10–11th ,,
First pre-molars	lower	11th ,,
Second pre-molars	upper	10–12th ,,
Canines	upper	11–12th ,,
Second pre-molars	lower	11–12th ,,
Second molars		12th ,,
Third molars		17–25th ,,

The arches are broader than the deciduous arches, and on account of both the increased size and number of the teeth the arches are much deeper antero-posteriorly. As in the deciduous dentition the upper arch is larger than the lower arch. Slight irregularities of newly erupted incisors may improve with further growth of jaws. A large diastema seen between the two upper central incisors will usually close with the eruption of the remaining front teeth. Excision of the frænum, once thought to facilitate this closure, is rarely necessary

The relationship of the arches to each other in the antero-posterior plane is such that by the age of twelve to thirteen years the antero-buccal cusp of the first, permanent upper molar occludes with the buccal sulcus of the first permanent lower molar (fig. 22). Given this relationship, the interdigitation of cusps requires the lower pre-molars and canines to bear a medial relation with their corresponding upper teeth. Where this relationship is upset errors in the position and relationship of the upper and lower anterior teeth are usual. The migration of permanent teeth, which follows the early extraction of deciduous teeth, is a common cause of a disturbance of this cuspal relationship with resultant ill effects upon the position of the anterior teeth. The extraction of the lower teeth is particularly damaging in this respect.

Disturbances of growth which finally lead to established malocclusion usually start in very early life. The reasons for these disturbances are obscure. The shape of the jaws may well be impressed upon them in part by their muscular environment. The diversity of activity in which the mouth at various times is involved (mastication, deglutition, speech, respiration), presents opportunity for aberrations of function.

Some consider that modern man makes insufficient functional demands upon the jaws, thus preventing the hereditary potentialities being fully achieved. The writer leans to the view that it is rather certain aberrations of the multifarious functions of the structures within and surrounding the mouth which lead to adverse moulding of the jaws and dental arches. These aberrations appear to be fostered in particular by an unhealthy naso-pharynx. From clinical experience it would seem that, apart from the conservation of the deciduous dentition, a healthy naso-pharyngeal mucosa during the first few years of life is the most valuable single agent for the promotion of normal development.

A few popularly accepted causes of disturbances of growth have no supporting evidence. There is no evidence that lack of breast-feeding leads to irregularities, or that adenoids *per se* produce narrow arches. Mouth breathing is often given as an etiological factor when the lips are seen to be held apart. Nasal breathing is usually still performed despite parted lips.

The Care of the Teeth

With the present knowledge of the underlying causes of dental decay disappointments and contradictions abound, but some positive information has followed from broad observations.

A well calcified tooth is able to withstand adverse oral conditions better than a poorly calcified one. The process of calcification taking place before birth is less likely to be adversely effected than in the early years of life when metabolism is more easily disturbed, but the nutrition and health of the mother must be adequate to the extra demands made upon her.

Once the teeth are formed evidence leads to the conclusion that they are not effected by systemic disturbances directly, though when erupted they are susceptible to local conditions which in turn may be influenced by systemic conditions.

Prophylactic measures may be said to be applicable from the onset of calcification of the deciduous dentition in intra-uterine life.

There is evidence that breast-feeding is associated with a relative immunity to caries. Among certain primitive peoples where it is customary to prolong breast feeding beyond our conventional period the incidence of decay is the least known in man. Raw cow's milk too imparts a high resistance to decay, but the present difficulty of obtaining it in a bacteriologically safe condition reduces its use. Sprawson found that, in a group of children living under institutional conditions, those who had been put on a *régime* of suitably adjusted raw cow's milk showed no evidence of caries at all. He stated that the milk seemed to have a profound influence on the development and calcification of the teeth of man. In Tristan da Cunha where until recently there was practically no dental caries, raw milk is a staple diet, but in view of subsequent investigations mentioned below, other factors may be of importance in producing local immunity. Pasteurized milk has been found to reduce the incidence of caries, but less effectively than raw milk. The milk *régime* requires to be continued until the crowns of all the permanent teeth are calcified, *i.e.*, thirteen years approximately. Even when it is started comparatively late when much of the calcification has been completed it still appears to be of benefit. At Christ's Hospital, Horsham, where eight hundred boys were getting nearly a pint of raw milk daily, the number of teeth which decayed was reduced to a third of the number when the investigation began. From 1903 a daily ration had been instituted and the amount gradually increased. The medical officer to the school wrote : 'If the dental figures are examined in relation to the amount of milk consumed per head a close correlation can be traced between the gradual improvement in general condition and the decreased evidence of caries.'

In areas where the water contains an abundance of lime salts there tends to be less decay than where the water is soft. Following the study of endemic dental fluorosis a significant relationship between caries and the fluorine content of domestic water supplies has emerged. In those areas in America where the water contains 5 parts per million and over teeth are mottled by opaque white patches which may take up a brown stain in time. Where the water contains 0·5 part per million and under caries attack is greater than where it is 1·0 part per million and over. A fluoride concentration of somewhere between 0·5 and 1·0 parts per million seems both to avoid mottling and to decrease dental caries attack.

In the light of this knowledge the high resistance to dental decay enjoyed by the inhabitants of Tristan da Cunha has been investigated further. It was found that they revealed some mottling of the teeth, but the concentration of the fluoride in their water supply was only 0·2 part per million, a concentration too low by itself to produce fluorosis. Their large daily intake of fish, however, with its relatively high fluorine content might produce a concentration sufficient to account for the slight amount of mottling and their immunity to caries.

Refined foods tend to be damaging to the teeth. They probably do not satisfy the chemical and vitamin requirements for perfect calcification. They also require less mastication. Vigorous mastication which unrefined food demands both cleans teeth and ensures proper ensalivation. A generous flow of saliva tends itself to aid cleansing.

The foods which are potentially the most dangerous are the carbohydrates, for it is from their acid products of fermentation that enamel can be decalcified. The sticky refined carbohydrates which undergo rapid fermentation in the mouth are to be most shunned. It is of value so to plan meals that the coarser and more detergent foods come at the end.

Brushing the teeth twice a day will help to prevent stagnation of food. Before retiring and after breakfast are probably the best times. On both the buccal and lingual aspects the motion of the brush should be from the gums to the crowns of the teeth, a horizontal motion being reserved for the biting surfaces. A satisfactory brush has a small head with bristles of medium-stiffness cut in varying lengths to form a serrated brushing surface. Precipitated chalk with bicarbonate of soda or a little soap makes a suitable dentifrice Common salt is also of value. The mouth needs to be rinsed afterwards by forcing water to and fro between clenched teeth. Abrasive dentrifices and stiff bristles will damage the teeth and gums in time. Even when employing proper agents it is as well to remember that if the teeth can be cleansed in a given interval of time they cannot be made cleaner by further brushing.

The risks of food stagnation are increased where the teeth are irregular, and in those who do not keep the lips closed the cleansing action of saliva is arrested.

Protection against caries may be briefly summarized as being best achieved by ensuring proper calcification of the teeth with a diet that covers nutritional requirements in essential constituents for the mother and later for the child, by protection against systemic conditions which disturb normal metabolism, and finally by fostering all the agents for local cleanliness.

R. Ernest Rix.

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CHAPTER VII

GROWTH

General Principles. Growth in the true sense of the word implies more than mere change in size and form. It includes that gradual development from the ovum to old age which involves the acquisition of new functions and fresh responses to the environment by the unfolding of new patterns of behaviour. Our real interest in children is not determined by their anatomy, but by their changing activity and behaviour as they pass from one developmental stage to another at varying rates.

It is necessary to consider the manner in which a growing organism, whether animal or plant, reacts to the conditions of its surroundings. Growth is at its maximum in the earliest stages of development. The human ovum two weeks after conception doubles its weight in six days. The human embryo of the third month doubles its weight in the next month, the newborn child takes six months to double its weight, and one year to treble its birth weight. There is a considerable body of experimental proof, ranging from the experiments of Vernon (1903) in animal life to those of De Vries (1903) in vegetable life, that external conditions do not act equally powerfully at all periods in the growth of a developing organism, but that the effect of the environment is the more noticeable as growth is the more active. It would appear to be a law of general application that the permanent effect of environment on the growth of a developing organism diminishes rapidly and regularly from the time of impregnation onwards.

In addition to the increased susceptibility to environmental conditions in periods of rapid growth, there is the well-established fact that the variability of response is greater during the earlier periods of growth. Babies vary more amongst themselves than do children or adults. Embryos vary more than babies. This is the scientific basis for the belief in the special influence of the condition of the mother at the time of conception upon the subsequently developing offspring.

The extent to which a retardation or acceleration of growth produced at any particular period of development may persist throughout childhood is difficult to assess in many cases. Such an effect, produced in the earliest stages, may be entirely compensated by a subsequent variation of the rate of growth in the reverse direction. The fact that variability in height and weight decreases with growth indicates that there is a definite tendency for previous irregularities to be eliminated.

The health of the mother during pregnancy, and of the offspring during their early years, is of paramount importance in its permanent effects on the physique, constitution and health of later years. Notwithstanding the checks and spurts of growth in childhood there is, as Lorrain Smith (1932) states, a ‘ Law of Uniform Stature ’ to which the organism tends to conform. Few are the adults who differ by more than 5 per cent. from the average stature of the race, or by more than 5 per cent. from the average for the circumference of the head.

The Growth Curve

The fœtus in the month before birth grows more rapidly than at any other period. During this month the infant increases his weight by 1 per cent. each and every day. If he continued to grow at this rate after birth, he would weigh 200 lb. at the end of the first year and at the end of twenty years would be as big as the earth. During the first year of post-natal life the babe grows rapidly and this period may be called the first springing-up period (fig. 23). From one to five years he grows more slowly and more steadily. This is the first filling-out period. From five to seven years there is a second springing-up period. It is at this stage that the child increases rapidly in height, loses his milk dentition, and begins to cut his second or permanent teeth, becomes thin and long in the leg and exchanges the chubbiness of babyhood for the characteristic family countenance. At seven years of age his brain is almost as large as it ever will be. Between seven and eleven or twelve, according to sex, occurs the second filling out period with steady growth as its characteristic, to be followed by the third springing-up period associated with puberty. The startling changes associated with the rapid growth of puberty give place to the third and last filling-out period, as puberty is succeeded by the period of adolescence.

Thus each ‘ springing-up ’ period is followed by a ‘ filling-out ’ period. Each ‘ springing-up ’ period has its own peculiar problems and to a lesser extent each ‘ filling-out ’ period has its peculiarities. All these periods are apt to be upset by oscillations of growth, and may be modified by diet, environmental conditions, and disease. The first ‘ springing-up ’ period presents the dangers of certain nutritional diseases such as rickets, scurvy, infantile diarrhœa and digestive disturbances. The second ‘ springing-up ’ period from five to seven years and the first 'filling-out' period immediately preceding it are peculiarly associated with the acute infections and fevers of childhood such as whooping-cough, measles, chicken-pox and diphtheria. The second 'filling-out' period, from seven to eleven or twelve, is the period during which the child presents in varying degree the sequelæ of these acute infections. The problems presented during this interval concern themselves

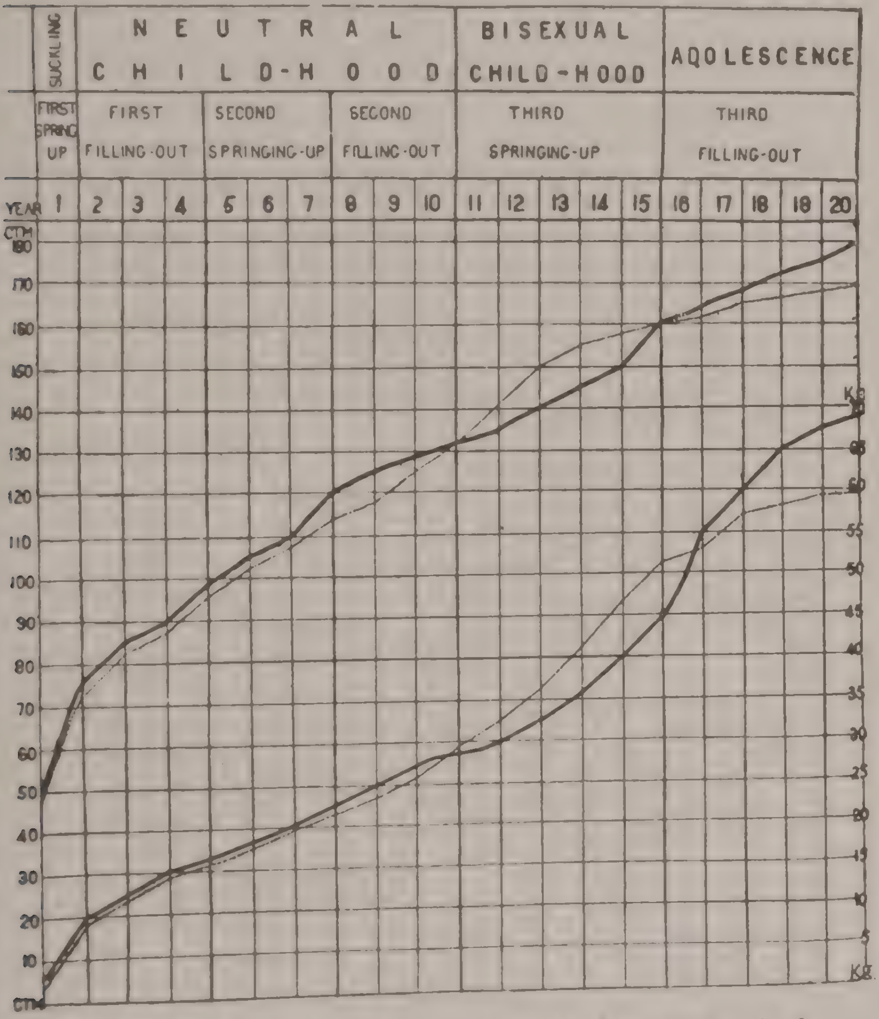

FIG. 23. The growth curve for height (cm.) and weight (kg.) in the child, to show the three 'springing-up' periods followed by the three 'filling-out' periods. Boys: continuous line. Girls: dotted line. (After Stratz. 'Der Körper des Kindes und seine Pflege,' 1922. Stuttgart.)

predominantly with the heritage of the diseases and deficiencies of the preceding years. Notably, defects of dentition and vision, enlarged tonsils and adenoids, middle-ear disease, and disease of the lymphatic glands in the chest, neck and abdomen call for urgent attention. This period of consolidation from the age of seven to that of eleven may be regarded at one and the same time as the opportunity for retrieving past errors of development and for preparing for the heavy demands necessitated by rapid growth during the third 'springing-up' period of puberty.

The type of growth registered by this curve is far from being an adequate representation of the profound changes taking place in any given child, and deals wholly with changes in height and weight. Practically every external lineal dimension of the body, with the exception of the head and neck, follows this type of growth. The growth of the skeleton, of the limbs, of the thoracic cage and respiratory organs and of the muscular system as a whole conforms to this general type of skeletal growth.

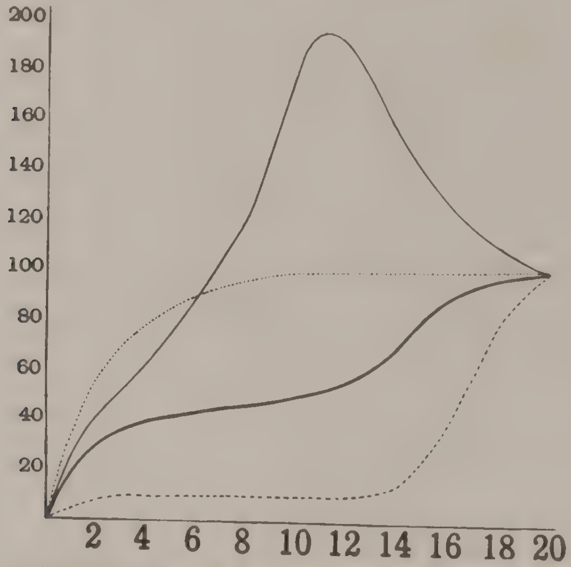

FIG. 24. The four types of growth: skeletal (heavy line), neural (dotted line), lymphoid (light line), urogenital (broken line). (After Scammon, R. E., 1930, 'The Measurement of Man.' Minnesota.)

The growth of the brain, the eyeball and the skull is peculiar. From birth to the age of eighteen months, these organs grow with extreme rapidity; by the age of two years they have reached 60 per cent. of their adult size, and by the age of seven almost adult size (figs. 24 and 25). This type of growth may be regarded

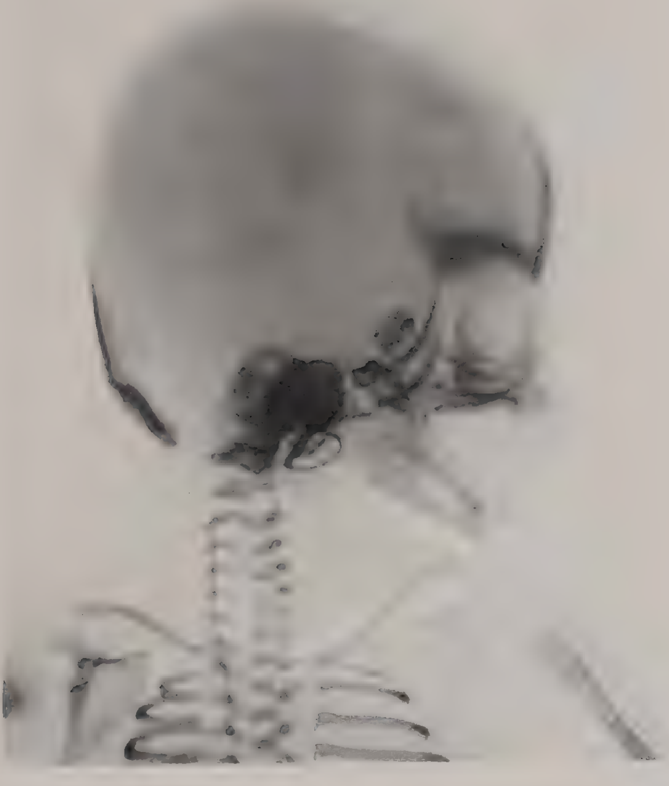

FIG. 25. Radiograph of the fœtus of six months to show the precocity in development of the semicircular canals and tympanic ring surrounding the drum of the ear. The apparatus for equilibration and hearing is virtually adult in size.

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TABLE 8.

Indicating the Percentage which the Principal Organs normally contribute to the Body-weight

	Percentage of the body-weight	
	In the new-born child	In the adult
Of Muscles	25·05	43·40
Skeleton	13·7	17·38
Skin and subcutaneous tissue	19·73	17·77
Brain	12·29	2·16
Liver	4·57	2·75
Stomach and intestine	2·1	2·06
Lungs	1·75	1·50
Heart	0·76	0·46
Kidneys	0·75	0·46
Spleen	0·34	0·25
Thymus	0·26	0·04
Eyes	0·24	0·02
Suprarenal glands	0·23	0·01
Salivary glands	0·21	0·12
Spinal cord (without membrane)	0·18	0·06
Thyroid body	0·16	0·05
Pancreas	0·11	0·15
Ovaries	0·026	0·012

(Vierordt, Daten und Tabellen, 1906, p. 44.)

as neural, and applies to the brain, spinal cord, eyeball, ear and skull, exclusive of the face.

The lymphoid tissue of the body, as illustrated by the lymphatic glands, tonsils and thymus, grows rapidly in childhood and continues to grow at a somewhat slower rate until puberty. During adolescence and adult life there is both an absolute and a relative decrease in the amount of lymphoid tissue. In view of the extent to which the lymphatic glands are involved in children at all ages as a result of acute disease and of chronic infections, this third type of lymphoid growth must be of deep significance.

The fourth type of growth is that presented by the genital organs. These organs grow but slowly in infancy, remain almost stationary from two to ten, and grow rapidly in the two years before puberty, during puberty and during adolescence.

Scammon (1923) lays emphasis on the fact that these four types of growth, general or skeletal, nervous, lymphoid and genital, are but crude representations of the complexity of the process involved. Dentition is not completed until about the twenty-first year when the ' wisdom ' teeth erupt. Growth in the face and neck continues to the same age. The suprarenal glands, the paired organs which lie in relation to the kidneys, lose one-half of their weight in the first two weeks of post-natal life, increase slowly up to the fifth year, and do not reach birth weight until puberty. The uterus, which grows rapidly in the last month of ante-natal life, loses 50 per cent. of its weight in the first two weeks of post-natal life and does not begin to grow appreciably until two or three years before the onset of menstruation.

The ductless glands, or glands of the endocrine system, which have provided material for so many remarkable experimental observations and for so much doubtful theorizing, present a picture which so far defies analysis. The thyroid gland displays steady growth from birth to maturity, with the tendency to enlargement in relation to puberty and pregnancy as a characteristic. The thymus follows the lymphoid type of growth. The pineal gland follows the nervous type, and the pituitary follows the thyroid. The suprarenal is in a class by itself. There is thus no trace of correlation in the growth pattern of the ductless glands.

It should be mentioned that the second ' springing-up ' period of growth between five and seven years is not so clearly indicated on some of the growth curves of height and weight as it in fact appears to the careful observer of young children. The cutting of the second dentition, often accompanied by nervous disturbances as significant as those of the first dentition, the marked lengthening of the face, the rapid development of the air sinuses in the face, and even the rapid lengthening of the foot in the sixth year, necessitating a larger size in footwear, the anxiety of the parents because the child is ' going thin,' the loss of subcutaneous fat—these are more evident to the careful observer of children than to the statistician. Mass statistics and curves compounded of many observations on different children tend to smooth out the spurts and checks which are so obvious on the curve for the individual.

It cannot be too strongly emphasized that there is no growth curve by which an individual child can be assessed. Even though both plants and animals tend to remain in adult life in that group into which they fall in the early stages of growth, there is no quantitative estimation of the genetic factors which result in the small babe growing to be a small man or in the big babe growing to be a big man. The differences between both animals and plants cannot be explained solely on the grounds of heterogeneity of environment. Neither the efficiency of the mother as extolled by

Paton and Findlay (1926) nor the health of the mother as emphasized by Elderton (1928) can be regarded as the all-determining factor in the growth of the offspring.

Slowness of Growth in Man

Man stands apart from all animals not only by reason of the lengthy period of gestation and the long drawn-out period of childhood, but also by reason of the long period of time involved in the transition from childhood through puberty to adolescence. The growth curve in most domestic animals presents a gradual decrease in the growth factor from birth to maturity with no periods of relative retardation or acceleration. The neo-natal loss of weight which is so common in the human baby, amounting from 5 to even 10 per cent. of the birth weight, is not a feature of the domestic animals. The growth curves in these animals display a rapid development from babyhood through childhood to puberty. The animal continues to grow for a considerable time after puberty. Most domestic animals arrive at puberty at a time when the body weight is roughly one-third of the mature weight. On the other hand, man alone has a long drawn-out period of childhood, with eight to nine years intervening between the period of commencement of the second dentition and the onset of puberty. At puberty the boy or girl is roughly two-thirds of the adult weight. Further, the boy or girl takes a proportionally much longer time to increase the weight from puberty to adult life than does the domestic animal. In sheep, the adult weight is reached about six to seven months after puberty, *i.e.*, the percentage decrease in the growth rate is about 15 per cent. In man, the adult weight is reached in nine to twelve years after puberty and the percentage decrease in the growth rate is about 3 per cent.

The absence of a period of rapid increase of growth at puberty in the domestic animals, in combination with a frank sexual behaviour pattern is well known. The presence of a period of rapid increase of growth at puberty, slightly earlier in girls than in boys, in combination with a prepubertal shyness, a pubertal reticence and a subsequent complex behaviour pattern indicates the danger of transferring data from animals to man.

Except in so far as it may resemble the growth curves of anthropoids (about which we have but meagre information), the growth curve in man is entirely distinct from that in all other animals. The latter afford but slight differences amongst themselves.

The Experimental Aspects of Retardation and Arrest of Growth

The lines of arrested growth due to acute infections or metabolic diseases such as diabetes have been analysed by Harris, H. A. (1933). Our knowledge of the arrest of growth in organs other than the skeletal tissues is but imperfectly understood. A considerable body of data relating to arrest and retardation of growth has been derived from animal experiment. The position was postulated by Darwin (1868) when he stated that 'of all the causes which induce variability, excess of food, whether or not changed in nature, is probably the most powerful.' The potency of food has been recognized more clearly in animal husbandry than in the home or the school. Growth can only take place at the expense of food material, and unless this is always more than sufficient for the needs of the organism, the rate of growth must be dependent upon it. There are innumerable experiments which prove that excess of food and heavy feeding is more advantageous and profitable in the youngest stages of animal husbandry. The statistical returns on this fact are incontrovertible, both as regards the experiments upon pigs performed by Gilbert and Lawes (1877) at Rothampsted and innumerable experiments upon animals since that date.

The recent animal experiments upon the retardation of growth have been directed mainly towards maintaining the growing animal at a constant weight over a period of time. The obvious methods, following the classification of A. H. Smith (1931), involved :—

(i) Limitation of total diet.
(ii) Limitation of total diet to minimal calorific value, but with the addition of the essential salts and vitamins.
(iii) Limitation of ingested water.
(iv) Restriction of protein.
(v) Restriction of salts.
(vi) Vitamin deprivation.
(vii) Increase of the concentration of waste products in the body, as by removal of one kidney.

In all these experiments it has been found that the problem of retarding growth is extraordinarily complex. For instance, an animal on a salt-free diet dies before an animal on absolute starvation. One of the most interesting results which have emerged is related to the effects of limitation of protein. Osborne and Mendel (1912, 1914) indicated the loss of appetite which is a feature of protein starvation. When animal and vegetable proteins are broken down to amino-acids by the action of the proteolytic ferments of the intestine (pepsin, trypsin and erepsin) it is found that the resulting amino-acids depend largely on the actual protein employed. Some amino-acids are not absorbed by the intestinal epithelium and are excreted as foreign bodies. The remaining amino-acids which are absorbed vary a great deal as regards their physiological significance. Thus an adequate protein is one which on digestion yields those amino-acids which are necessary for growth and repair of the tissues, and an essential amino-acid is one without which growth or repair cannot take place. There is now agreement that lysine, cystine, tryptophane and histidine are definitely essential amino-acids, and it is generally accepted that phenylalanine, tyrosine and proline are probably essential to physical well-being. It is of interest to note that two vegetable proteins, the gliadin of wheat and the hordein of barley, are relatively poor in some of these essential amino-acids which are more readily provided by the digestion of animal protein, particularly milk, eggs, fish and meat. There is thus incontrovertible proof that man is essentially an omnivorous animal. Wheat and barley have been used as a large and essential part of the diet in those experiments where growing animals have been kept at a constant weight over a considerable period of time.

The experiments of Harris, Neuberger and Sanger (1943) prove that in the young rat fed on an unlimited diet of gliadin 18 per cent., arachis oil 10 per cent., lard 5 per cent., cod-liver oil 1 per cent., salt mixture (McCollum) 5 per cent., corn starch 61 per cent., adequate water soluble vitamins, and a supplement of 10 mg. of l-tryptophane, growth does not take place because of the absence of lysine in gliadin. The same result occurs when the gliadin of wheat is replaced by the zein of maize, and the animal remains at constant weight. The addition of 40 mgm. of the essential amino-acid, lysine, leads to a gain in weight of 1 g. per day.

This is the scientific reason for advising the use of cereals, such as wheat and barley, in their cheaper forms, *e.g.*, bread or dry toast, rather than in the form of various patent preparations such as packed breakfast cereals or biscuits, especially in cases where economy is a consideration. Fresh cow's milk, eggs, butter, cheese, meat and fish are a better investment both as regards essential proteins and fat.

Of all the methods of rapidly arresting growth, salt starvation and the withdrawal of fluids are the most potent. Even to-day, when the significance of salt balance in the diet is well recognized, the provision of adequate fluid either as milk, skim-milk, oatmeal-water, barley-water or plain drinking water does not hold as important a place in the school and home as it does in animal husbandry.

The various vitamin requirements are dealt with in Chapter IV.

Growth of the Skeleton

The skeleton passes through the successive phylogenetic stages of connective tissue, cartilage and bone (fig. 26). The progress of the successive stages varies considerably in different parts of the skeleton. The fontanelles in the skull of the infant are persisting parts of the membranous connective tissue skeleton, as the nasal septum is a persisting part of the cartilaginous skeleton in the adult. Most of the membranous skeleton passes into the cartilaginous stage during the fifth and sixth weeks of embryonic life. Certain rapidly growing parts such as the bones of the vault of the cranium, most of the bones of the face, and the clavicle pass rapidly from the membranous stage to the osseous stage with but minimal formation of cartilage. The vertebral column and appendicular skeleton, together with the base of the skull, tend to grow more steadily, with the result that the intermediate cartilage stage persists long after birth.

Cartilage, as a tissue, is essentially devoid of blood vessels and is nourished by tissue juice. As soon as a mass of cartilage in any part of the skeleton reaches a particular size, conditions of nutrition at the centre of the mass become difficult, the cells age rapidly, the intercellular matrix undergoes calcification, and is rapidly replaced by a young vigorous tissue, richly provided with blood vessels. This is osseous tissue or bone. The avascular cartilage has great powers of steady growth up to a certain limiting size, but no powers of repair; the highly vascular bone has great powers of both growth and repair.

The total number of bones in the skeleton varies with age. There are great differences in the rates of bone formation in the different parts of the skeleton. The clavicle, mandible and maxilla commence to ossify at the end of the fifth week of embryonic life. Centres of ossification appear rapidly in the ribs, long bones of the limbs and in the centrum and lateral masses of the vertebræ. At birth there are about 400 centres of ossification present in approximately 270 bones (fig. 27). In infancy the number of centres of ossification may be reduced by union of two or more primary centres which were present before birth, but from infancy to childhood there is a steady increase in the number of centres of ossification present. These are mainly primary centres in the bones of the carpus and tarsus and the large number of secondary

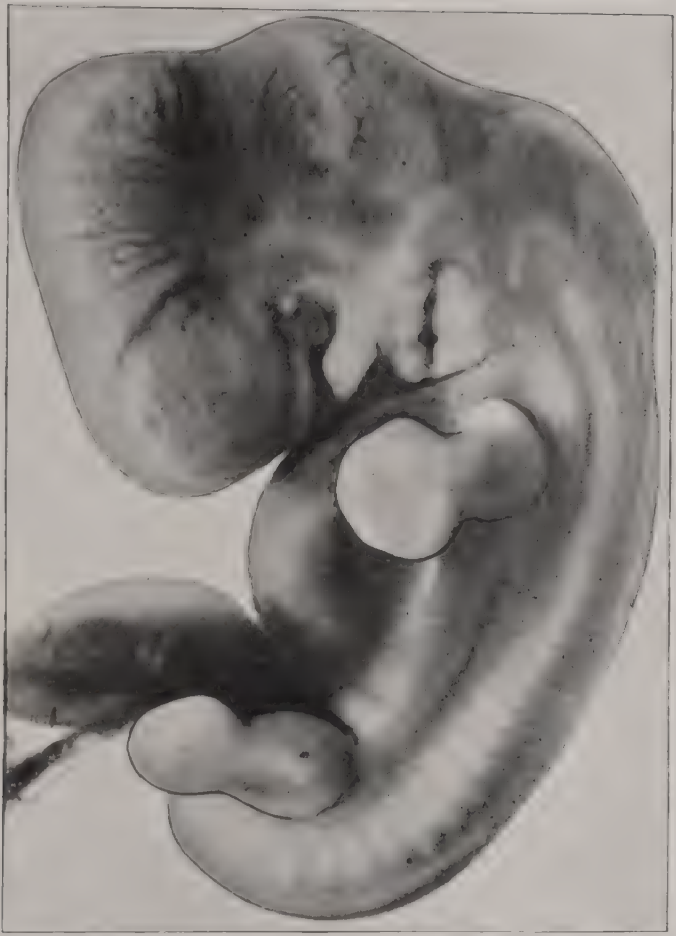

FIG. 26. Human embryo of about five and a half weeks showing the primary curve of the spine in the mesenchyme stage when cartilage is appearing in the vertebræ and ossification has not yet occurred. (No. 801 in Professor J. P. Hill's collection at University College, London. Harris, H. A. 1943. *Proc. Roy. Soc. Med.*, **36**, 300.)

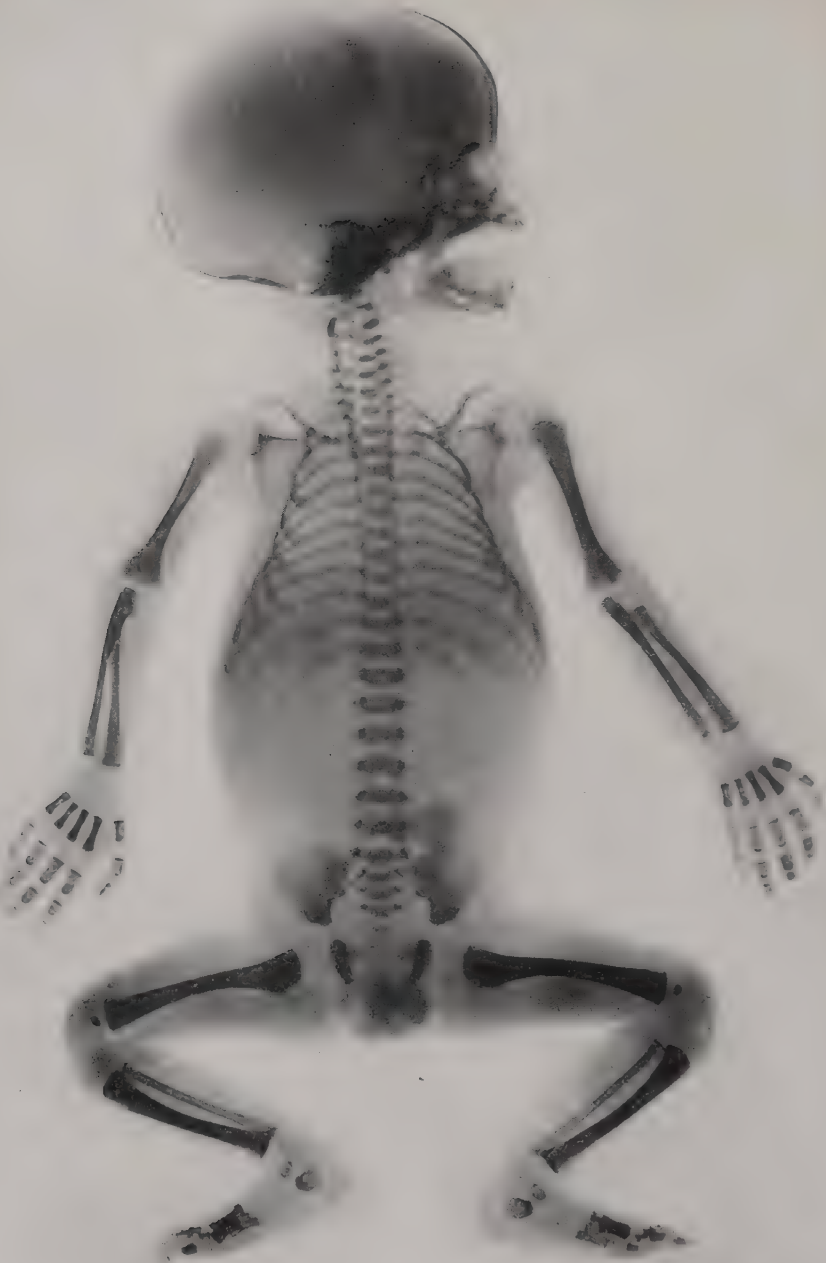

FIG. 27. Radiograph of the newborn. The centre of ossification in the distal epiphysis of the femur appears about two weeks before term.

centres which appear in the vertebræ, limb girdles and long bones before and about puberty. From puberty onwards through adolescence to maturity fusion of centres of ossification leads to a reduction in the number of bones, so that in the adult the number of bones in the skeleton is about 206 as compared with about 350 separate bony masses at puberty. In the adolescent the cartilage skeleton gives way to the bony skeleton, the cartilage remnants occupying the articulating surfaces of the diarthrodial joints, and the fibrocartilages of the spine, sternum and symphysis.

Radiographic Assessment of Age

The chronological age of the child is but a crude index of the stage of skeletal growth, neural growth or behaviour which has been reached by it. By careful analysis radiographs of the skeleton and in particular of the wrist and hand, afford concrete knowledge of the skeletal age. It is possible to assess the precocity or retardation of skeletal growth in the child. The time and order of appearance of primary centres of ossification in the carpus and tarsus, and of secondary centres in the long bones, follow a fairly constant pattern in both sexes. The centres of ossification in the newborn girl tend to appear a few days ahead of the corresponding ones in the boy. As Pryor (1923) first pointed out, in infancy the precocity of ossification in the girl can be measured in weeks, in childhood in months, and at puberty it may reach eighteen months to two years. Similarly, fusion of the epiphyses with the diaphysis occurs earlier in girls than in boys in accord with the earlier onset of puberty, adolescence and maturity. The female skeleton is mature at about eighteen, the male at twenty to twenty-one, though union of the epiphyses of the spine may not be complete until two to three years later.

The tables (9 and 10) give the approximate age of appearance of various primary and secondary centres and the age of completion of their fusion. On the whole the radiographic skeletal age can be assessed more accurately in the first seven years and from puberty to adolescence than in the more neutral years from seven to eleven. For details of radiographic appraisement the monographs by Köhler (1928), Ruckensteiner (1931), and Wingate Todd (1937), should be consulted.

Certain epiphyses are of particular importance medico-legally or clinically. The ossification centre for the lower end of the femur (fig. 27) usually appears at about eight to ten days before term, so that its presence is evidence of maturity of the fœtus. The centre for the upper end of the tibia is often present at term

TABLE 9

Approximate Dates of Appearance of Centres of Ossification

THE WRIST

Os capitatum (magnum)	4 months	± 4
Os hamatum (unciform)	5 ,,	± 4
Os triquetrum	3rd year	± 1
Os lunatum	4th ,,	± 1
Os multangulum majus (trapezium)	6th ,,	± 1
Os multangulum minus (trapezoid)	6th ,,	± 1
Os naviculare (scaphoid)	6th ,,	± 2
Os pisiforme	10th ,,	± 3
Distal epiphysis of radius	2nd ,,	± 1
Distal epiphysis of ulna	8th ,,	± 1

THE ELBOW

Proximal epiphysis (head) of radius	5th year	± 1
Proximal epiphysis (olecranon) of ulna	10th ,,	± 1
Distal epiphysis (capitulum) of humerus	2nd ,,	± 1
Distal epiphysis (trochlea) of humerus	5th ,,	± 1
Medial epicondyle of humerus	6th ,,	± 2
Lateral epicondyle of humerus	13th ,,	± 2

THE ANKLE AND FOOT

Distal epiphysis of tibia	1st year	± 1
Distal epiphysis of fibula	2nd ,,	± 1
Os calcis	7th month antenatal	
Os astragalus (talus)	8th ,, ,,	
Cuboid	1st month postnatal	
Cuneiform, 3rd lateral	1st year	± 2
Cuneiform, 2nd intermediate	3rd ,,	± 1
Cuneiform, 1st medial	3rd ,,	± 1
Navicular	3rd ,,	± 2
Secondary epiphysis of os calcis	8th ,,	± 1

THE KNEE

Distal epiphysis of femur	*c.* ten days before term	
Proximal epiphysis of tibia	Postnatal 1 month	± 1
Proximal epiphysis of fibula	5th year	± 2
Patella	4th ,,	± 2
Tubercle of the tibia	12th ,,	± 2

TABLE 10

Approximate Dates of Completion of Union

	Female	Male
Scapula and coracoid in glenoid cavity	11	12
Ilium, ischium and pubis in acetabulum	13	14½

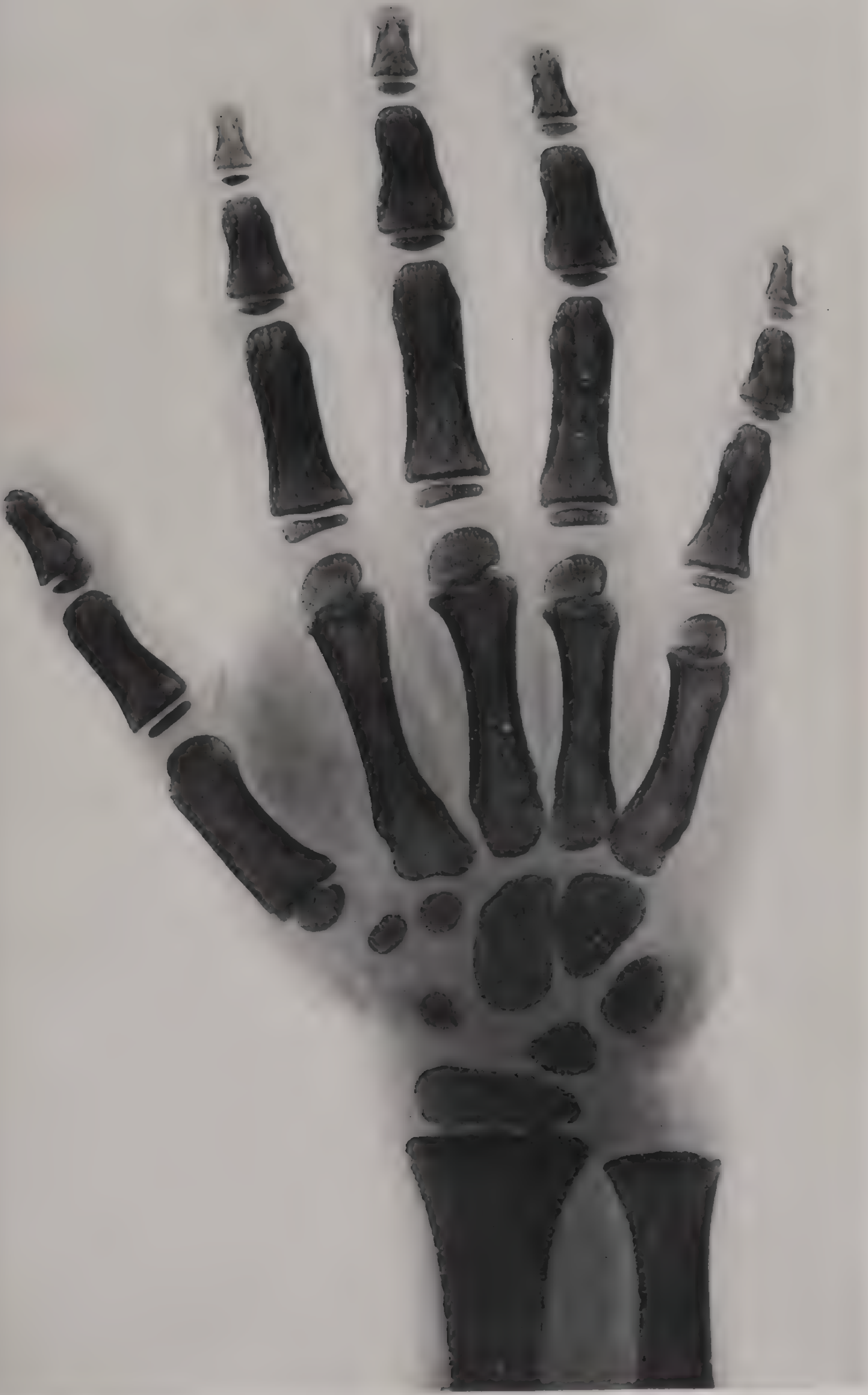

FIG. 28. Normal radiograph of the hand of a boy of five years: The distal epiphysis of the ulna has not commenced to ossify. All the carpal bones, except the pisiform, are partly ossified.

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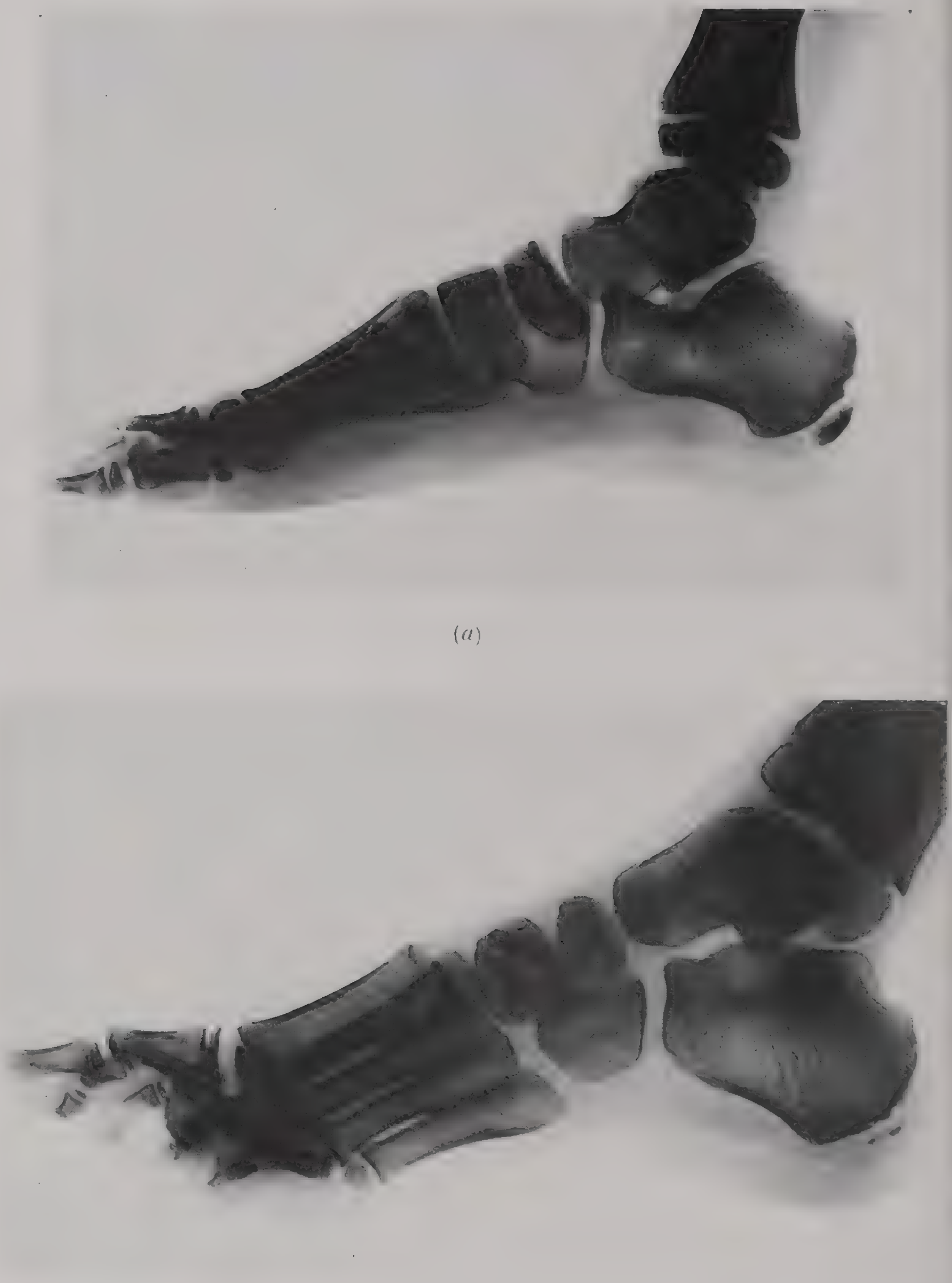

(*a*)

(*b*)

Fig. 29 *a* and *b*. Normal radiographs, reduced to scale, of foot (*a*) in a girl of six years eight months, showing the precocious development of the secondary centre in the os calcis at the attachment of the tendo Achilles; (*b*) in a boy of seven years ten months, showing the later development of the secondary centre in the os calcis.

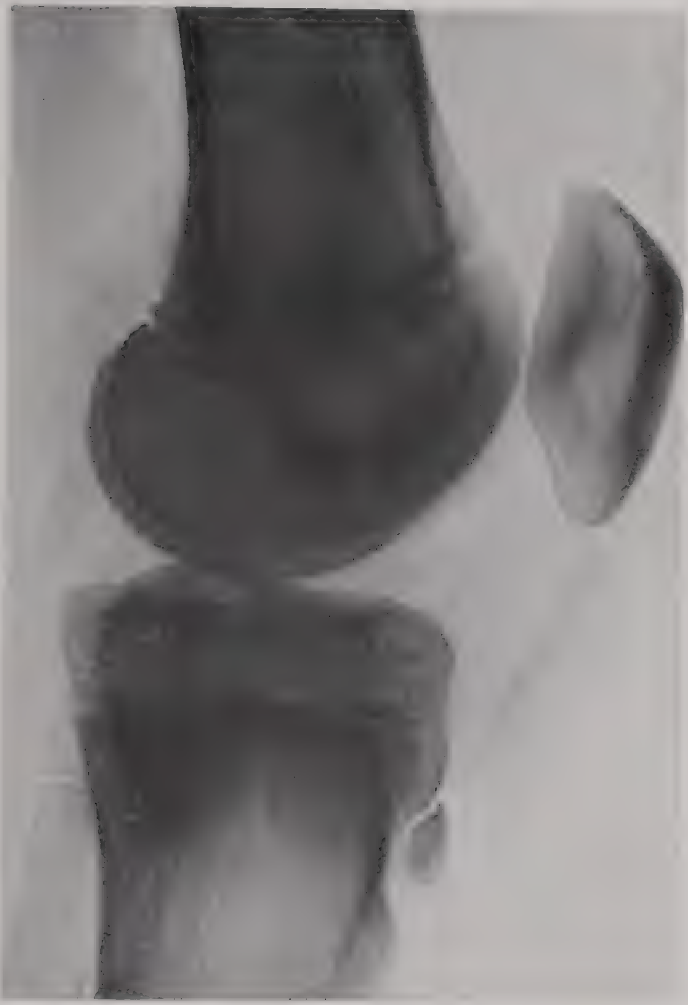

FIG. 30. Lateral radiograph of the knee of a boy of 14½, showing the centre of ossification for the tubercle of the tibia at the insertion of the ligamentum patellæ. This centre appears about two years earlier in the girl.

and very occasionally that for the upper end of the humerus and the coracoid. If all these are present it is proof of postmaturity. In the hand the os magnum (capitate) and the os hamatum (unciform) may be ossified in part in the post-mature infant, as is usually the cuboid in the foot. The os calcis and astragalus appear in the seventh and eighth months of intrauterine life. The secondary centre in the epiphysis of the os calcis, at the insertion of the tendo Achilles, appears about two years earlier in girls than in boys—at six and eight years respectively (fig. 29). The separate centre for the tubercle of the tibia at the insertion of the patellar tendon appears about four to five years later and is of particular interest in Schlatter's disease (fig. 30). Details of the pathological changes in rickets, scurvy and other infantile diseases together with their radiographic interpretation are discussed by Harris (1933).

For ordinary routine work in the clinic it is advisable to concentrate on the variation in the radiographic appearance of the wrist and hand (fig. 28) in the case of the younger children and of the knee in the older children (fig. 30). The times of appearance of the various centres of ossification may be either earlier or later than the average. Retardation or precocity has been partially analysed in terms of race, sex, social status, endocrine disturbance, nutrition, feeble mindedness (Todd, 1933 and 1937).

The real advantage of skeletal age, apart from all possible factors involving ossification, is that late maturing types can be divided from early maturing types. On radiographic analysis a school class of boys averaging fourteen years ± two months may display a skeletal age ranging from twelve years to seventeen years. Those with a twelve-year skeletal age at fourteen years of chronological age are of the later-maturing type with postponement of puberty. Those with a skeletal age of seventeen years are of the early maturing type with early onset of puberty and relatively early cessation of growth. The skeleton becomes knit at an early age. In these cases the androgenic hormones in the urine have been estimated and their production parallels very closely the skeletal age, not the chronological age (Greulich *et al.*, 1942).

Our social conventions, and in particular the Ministry of Education, compel a child to fit himself into a scholastic, intellectual and social environment based upon his chronological age. The unchallenged observations of Wingate Todd, Walter Greulich and many others indicate that appraisement of radiographic assessment of age should be used in school and in juvenile entrants to industry and the armed services. Moreover, the recent enthusiasm for the introduction of sex education in schools is complicated by the fact that children of the same chronological age in the same class may exhibit a range of five years in sexual development and behaviour (see Chapter XV).

The Skull

The skull of the newborn babe illustrates marvellous ingenuity in arranging for the dangers of the passage through the birth canal, in conserving the integrity of the alimentary and respiratory pathways, in protecting the brain and organs of special sense and yet allowing for future growth of all the parts, and particularly of the brain—the precocious master organ of the body. The radiograph of the skull of a newborn babe (fig. 31 *a* and *b*) indicates the radiographic features of the membrane bones of the vault as compared with the cartilage bones of the basi-cranial axis (fig. 25). The cranium proper presents a rude outline of the shape it is destined to assume in accord with the underlying brain. The face, on the other hand, diminutive at birth, is destined to undergo great modifications in accord with the eruption of the primary and secondary dentitions. The cranium and the contained brain exhibit marked precocity of growth and by seven years of age have reached almost adult size. On the contrary the growth of the bones of the face and the eruption of the third molar teeth is incomplete even at adolescence. The number of separate bones in the skull at birth is greater than the number in adult life. The number of bones in the fœtus is greater than the number in the newborn. The occipital bone of the adult consists of four elements at birth. The articular condyle for the atlas is formed in part by the basiocciput and exocciput. The hypoglossal canal for the hypoglossal nerve is situated between the basiocciput and the exoccipital elements. The temporal bone at birth consists of four elements, the cartilaginous petrous and styloid, the membranous squama and tympanic ring, together with an element consisting of the ossicles of the ear. The articulation on the temporal bone for the condyle of the mandible consists of three elements which contribute to the glenoid fossa, the squama, the tympanic ring, and the narrow strip of the petrous-temporal bone which presents itself at the Glaserian (petro-tympanic) fissure. The frontal bone, the sphenoid, the temporal bone, the occipital bone and the inferior maxilla display fusion of their constituent parts in early childhood. The first fusion between distinct bones in the skull, with the exception of that between the premaxilla and maxilla, which occurs in fœtal life, is that between the basiocciput and the basisphenoid in adolescence. The bones of the vault which appear in membrane so early in fœtal life continue to

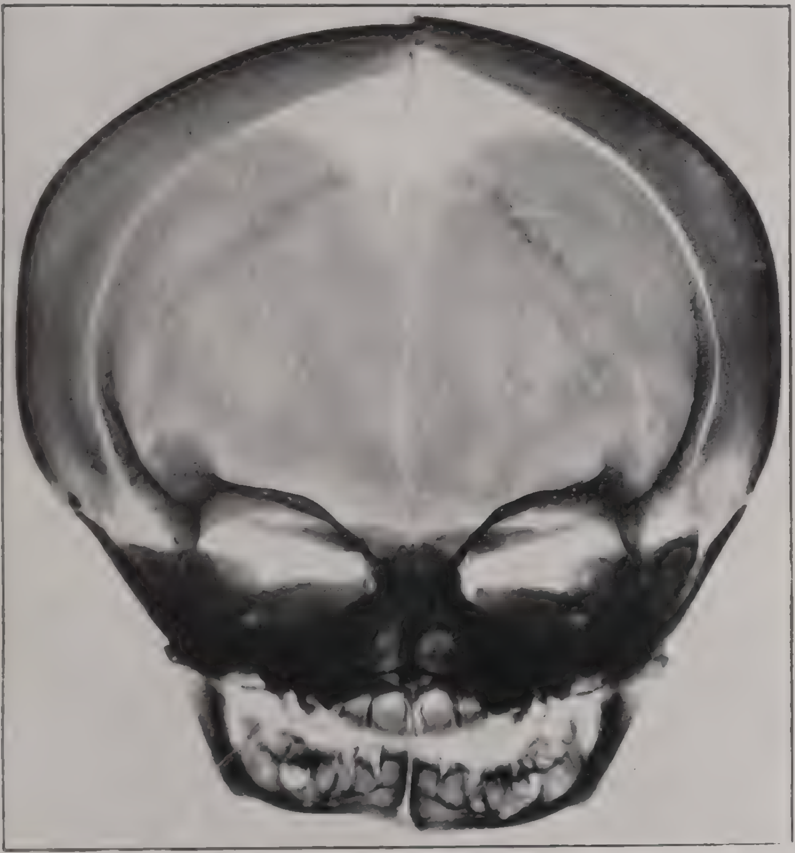

FIG. 31*a*. Radiograph of the skull of newborn infant: Norma frontalis. (From Harris, H. A. 1933. 'Bone Growth in Health and Disease.' Oxford University Press.)

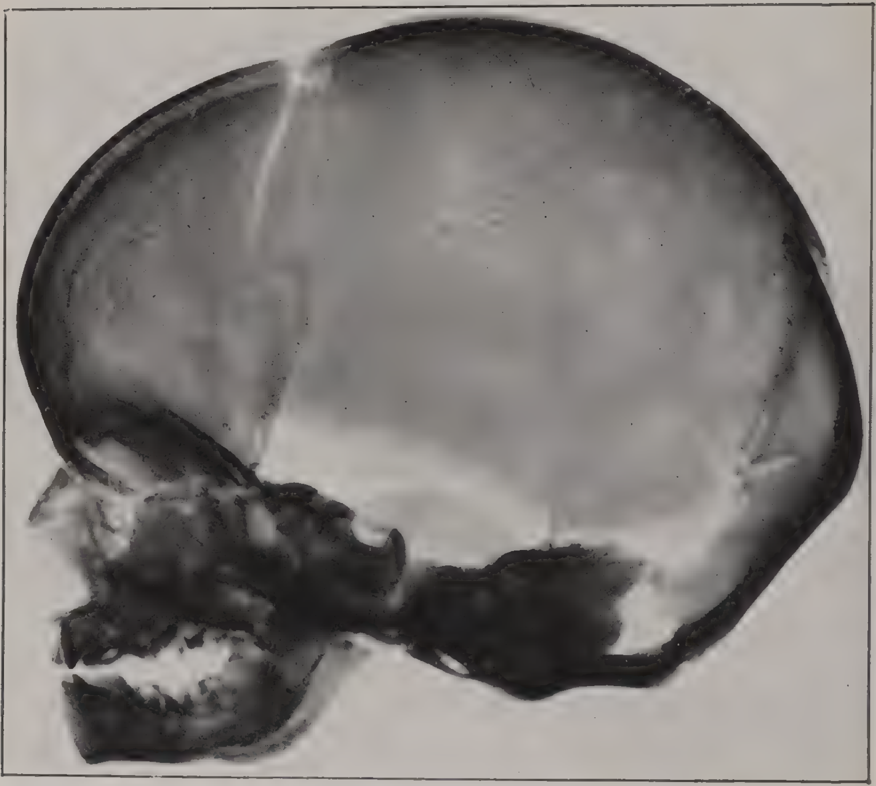

FIG. 31*b*. Radiograph of the skull of newborn infant : Norma lateralis. (From Harris, H. A. 1933. 'Bone Growth in Health and Disease.' Oxford University Press.)

grow from childhood at their margins. The growth is such that continuity never replaces contiguity at the sutures.

Fontanelles

At birth the fontanelles are sheets of membrane between the angles or margins of certain bones of the vault or calvarium. They are persisting parts of the membranous skeleton and consist of an outer layer continuous with the pericranium, an inner layer of connective tissue, rich in blood vessels, which is later modified by the ingrowth of membrane bone. There are six fontanelles normally present at birth; the large frontal fontanelle, and the smaller occipital fontanelle are both situated in the midline. The smaller paired fontanelles are in relation to the antero-inferior and postero-inferior angles of the parietal bone and are called the sphenoidal and mastoid fontanelles respectively. Rarely there is a small glabellar fontanelle between the two halves of the frontal bone and the nasal bones, a small metopic fontanelle in the metopic suture between the left and right halves of the frontal bone, a small parietal fontanelle half way along the sagittal suture, and a small cerebellar fontanelle at the incompletely ossified posterior margin of the foramen magnum.

The anterior fontanelle at which the pulsation of the brain can be seen and felt and its respiratory excursions observed, closes gradually. At two years closure is complete in about 80 per cent. of cases. Patches of hyperæmic scalp over the fontanelles are almost a normal feature at birth. The metopic suture between the two halves of the frontal bone can be felt in the newborn. It sometimes forms a prominent keel on the forehead in childhood. The metopic suture is usually completely ossified by the end of the seventh year, at which time the bones of the vault are clearly divided into an outer and an inner table by the development of the intervening diploë which gives the characteristic fine mottling to the radiographic appearance of the bones. The metopic suture persists in about 7 per cent. of European skulls.

The Spine

As Ward (1876) said: ‘The vertebral column is a remarkable piece of mechanism. Strong enough to support several hundredweight, yet pliant and elastic: furnished with levers and muscles by which it is bent in every direction, yet lodging an organ susceptible to injury from the slightest pressure: formed for lightness, of a loose and reticular tissue, yet capable of sustaining, without fracture, shocks, strains, and contortions of considerable violence: this column certainly combines the most opposite qualities, and performs functions apparently incompatible.'

In the infant each vertebra consists of three bony parts, a centrum and two lateral masses, separated by the neurocentral articulation, which consists of a plate of cartilage faced on both sides by a thin layer of calcified cartilage (Harris, 1933). The presence of three tissues so different in physical properties as bone, cartilage, and the intervening calcified cartilage is in itself a source of mechanical weakness in each vertebra. Active growth in size of the vertebra takes place at the neurocentral articulation (fig. 32). The cartilage plates grow in thickness, cartilage is calcified and replaced by bone: the three constituent parts of the vertebra are carried further apart. The cartilage plates are true epiphysial plates, and are therefore subject to all those injuries and diseases which take place in the fast-growing epiphysial plates of the long bones. Bony union of the centrum and lateral masses to form the definitive vertebra by calcification and ossification of the neurocentral articulation is completed by six years of age.

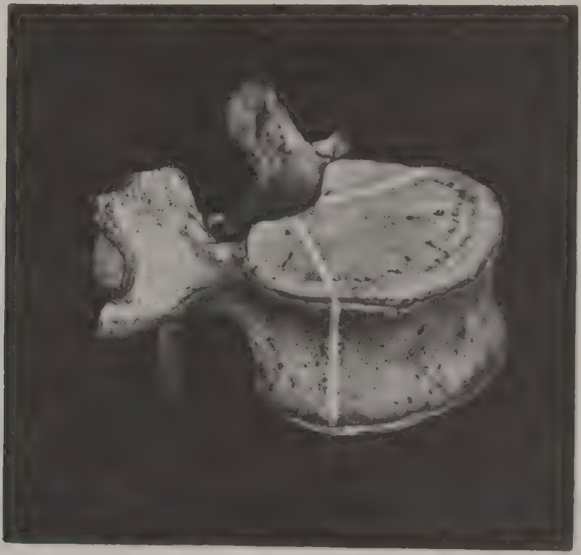

FIG. 32. Lumbar vertebra of an adolescent male of eighteen years, showing the annular epiphyses above and below the body. The site of the neurocentral articulation between the centrum and the right and left masses is indicated by white lines. These three pieces unite by the seventh year, when growth in the diameter of the spinal cord ceases.

In later childhood the spine consists of individual bony vertebræ, covered above and below by cartilage plates, and separated from one another by intervening fibro-cartilages. At puberty certain changes take place. Annular epiphyses of bone appear in the cartilage plates above and below each vertebra, so that the vertebra now consists of bone, epiphysial bone, epiphysial cartilage, and calcified cartilage (fig. 33). This increase in the heterogeneity of the tissue elements in the spine accounts for its special susceptibility to deformity and disease in puberty and adolescence. Kyphosis, lordosis, and, in particular, scoliosis may appear. The vertebra with its superior and inferior epiphysial bony annuli is not consolidated by cessation of growth, calcification, and ossification of the epiphysial cartilages and final union of the annular epiphyses until about twenty-three to twenty-four years in the male and twenty to twenty-one years in the female, when all growth has ceased in the long bones.

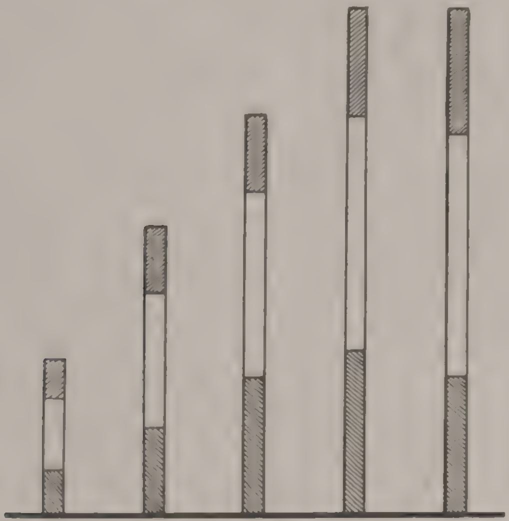

Fig. 33.—Diagram showing the relative lengths of the cervical, dorsal, and lumbar spine at (1) birth, (2) two years, (3) eleven years, (4) adult, (5) at birth, magnified to adult size.

The growth in length of the spine as a whole is most rapid in the first two years of life, when it increases from 8 inches to 16½ inches (20·3 to 42 cms.). Growth is then fairly regular and does not show the spurts which are registered so frequently in the lower limb The adult spine in the male approximates closely to 28½ inches (72·4 cms.) and in the female to 24½ inches (62·2 cms.). Growth in the spine is not truly proportional, but takes place at varying rates in different parts, particularly during the first seven years of life (fig. 33). Roughly speaking, at birth the cervical, lumbar, and sacral parts of the spine each contribute one-fifth of the total length, the dorsal or thoracic region occupying two-fifths. From birth to adult life the spine increases in length by three and a half times, but whereas the cervical region increases threefold the lumbar region increases fourfold, so that the greatest growth is in this region and is associated with the great growth in the lower limb—the skin, musculature, and joints of which are largely supplied by lumbar nerves.

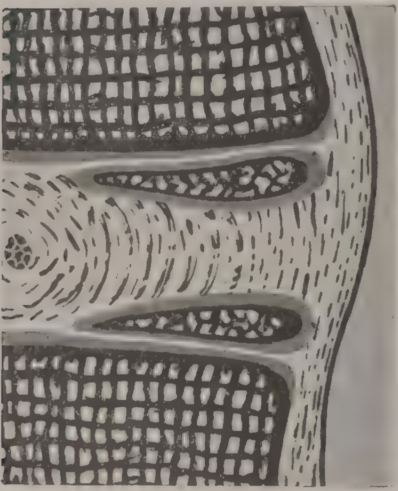

FIG. 34. Diagrammatic longitudinal section through two neighbouring vertebræ and their annular epiphyses at about eighteen years of age. The thin epiphysial cartilage (white) is separated by calcified cartilage (gray) from the neighbouring bone (black). The nucleus pulposus lies nearer to the spinal canal than to the anterior common longitudinal ligament of the spine, and so may be displaced backwards into the canal.

The growth in transverse dimensions of the spine is determined essentially by the growth in the spinal cord. At six years of age the spinal canal is larger than in the adult and the spinal cord is almost adult in cross-section. This precocity in growth of the spinal cord determines the time of onset of calcification and ossification in the neurocentral synchondrosis. Moreover, the epiphysial rings above and below each vertebra are an index of the attempt so to modify and control the growth of the spine that spine length shall be almost constantly 28½ inches in the male and 24½ inches in the female, in accord with a spinal cord length of 18 inches (45·7 cms.) and 16½ inches (41·9 cms.) respectively. This relative lack of variation in spine length in the two sexes accounts for the trade in ready-made shirts, coats, and corsets, of given length but varying girths. Throughout puberty and adolescence the spine does its utmost to reach its normal length, irrespective of stature.

The Intervertebral Disks

The intervertebral disks are more complicated in structure than the vertebræ themselves. The nucleus pulposus at the centre is essentially a remnant of the primitive notochord. This is surrounded by the annulus lamellosus, which consists of concentric lamellæ of fibrous tissue, some of the fibres circular, some spiral. Above and below this element are two cartilage plates bounding the adjacent vertebræ. Some fibres are inserted into the cartilage plate, some into bone, and some into the anterior and posterior common longitudinal ligament. Humphry (1858) described the nucleus pulposus as a 'fluid ball girt by surrounding bands of fibrous tissue . . . which the adjoining vertebræ rotated in their movements on one another.' This ball-bearing function of the nucleus pulposus is of the utmost importance, for the disks as a whole are more susceptible to age changes and to injuries than the bony vertebræ themselves.

The growth of the intervertebral disks is extremely interesting. At birth the nucleus pulposus is small and the disk is relatively narrow. The lamellæ of fibrous tissue develop after birth and are distinct entities at six months, when the child is first able to hold up its head. With age the fibrous rings grow at the expense of the adjoining cartilage plates. At birth approximately one-third of the total length of the spine is due to the disks, which are practically half as deep as the individual vertebræ. At seven years of age and on to adult life the disks account for one-fifth of the total length, so that they are roughly one-quarter the depth of the vertebræ. But the thickness varies considerably in different parts of the spine. Between the shoulders, in the upper thoracic region, the disks are thin, in accord with the reduced movements of flexion and extension in the vertebræ of a region subjected to the pull of the large muscles of the head and neck and upper limb. The disk between the second and third cervical vertebræ is thinnest of all. In the lower dorsal region the disks gradually increase in thickness, reaching their maximum in the lumbar region. This is due partly to the range of movement between the neighbouring vertebræ and partly to the large area of the contiguous surface which naturally tends to restrict the range of movement.

From birth to adolescence the total depth of the disks increases from 0·3 to 0·7 inches (0·76 to 1·78 cms.) in the cervical region, from 0·65 to 1·45 inches (1·65 to 3·68 cms.) in the dorsal region, and from 0·42 to 1·7 inches (1·07 to 4·32 cms.) in the lumbar region. Thus the outstanding feature of the spine in man is the great size of the lumbar vertebræ and still more the thickness of the lumbar disks. In all quadrupeds the epiphyses of the vertebræ are relatively thick plates instead of rings, and the disks are relatively thin. Only in man and the great apes are the plates reduced to rings and the lumbar disks increased so much in thickness (fig. 32). The range of movement and the large crosssectional area in the lumbar and lower cerivical spine are associated with the attempt to assume and maintain the erect attitude. Man alone has massive lumbar vertebræ, thick lumbar disks, annular epiphyses, huge buttocks, massive quadriceps, and long lower limbs. Even the gorilla, chimpanzee, and orang have failed to grow buttocks. It is only within recent years, as the result of the earlier isolated studies of Schmorl (1931) in Dresden, that the frequency of lesions in the intervertebral disks has been appreciated. More than 80 per cent. of these lesions are in the lumbar region, according to a recent report from the Mayo Clinic (Walsh and Love, 1939).

Most of the exercises found in the handbook of physical training, if employed without due care and supervision, may tend to abuse these recently acquired and peculiarly human features of the spine. Toe-touching and trunk-twisting are fraught with danger, particularly at such ages and in such types of build as are characterized by relatively long legs and short arms. Mobility of the spine, like the back view of the torso, is largely an individual characteristic. The rough-and-tumble of ball games is less dangerous than squad drill or organized ' jerks.'

The Primary and Secondary Curves of the Spine

The fœtus *in utero* presents a gradual curve of the spine concave forwards from the head to the coccyx (fig. 26). This primary curve persists in the thoracic and sacral regions. The cervical region develops a curve in the opposite direction, convex forwards, at about four to six months when the infant is able to sit up and control the movements of the head in all directions. This is the secondary cervical curve and failure to develop it, as shown by lateness in sitting-up, is due either to muscular weakness or to excessive weight of the head. When the child begins to walk early in the second year, a secondary lumbar curve is developed, convex forwards. This curve is normally more marked in the female than in the male, and is exaggerated in the pot-bellied. The thoracic region, in which flexion and extension is limited and rotation relatively free is a peculiarly personal feature so that it is as easy to recognize a child or adult by the ' set ' of his back as by the features of his face.

In old age or even in childhood in the presence of chronic bronchitis and asthma, the secondary curves of the cervical and lumbar region tend to be lost and the spine as a whole returns to the single primary curve. This fact calls for great care in any attempts to increase the mobility of the spine as a whole by graduated exercises.

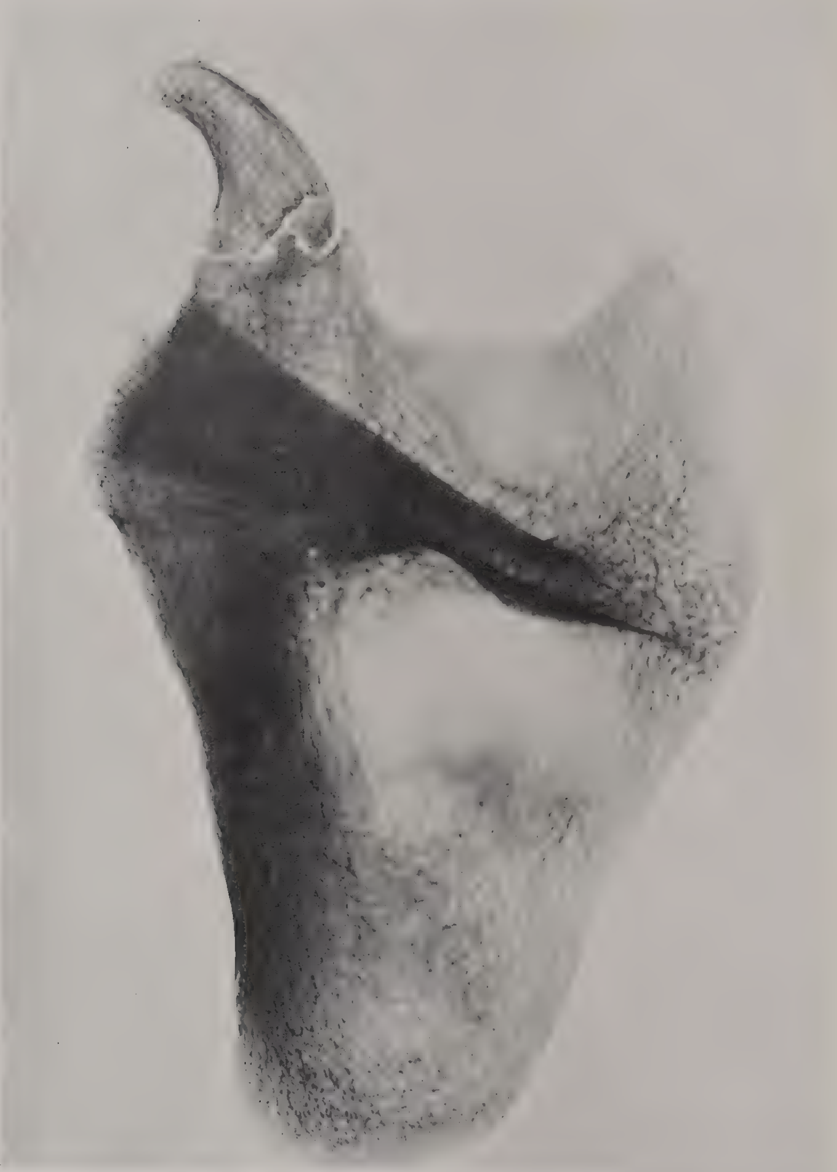

FIG. 35. Radiograph of the shoulder blade of a boy of fourteen, showing the band of cartilage between the coracoid above and the scapula below. Both bones and the cartilage are in part involved in the glenoid cavity of the shoulder joint.

To face p. 161.]

The Upper Limb

The shoulder-blade in childhood consists of two bony elements—the scapula and coracoid—separated by a band of actively growing cartilage (fig. 35). Thus the shoulder-joint comprises on the one hand the head of the humerus and on the other the glenoid cavity, consisting of two elements separated by an intervening band of cartilage, the scapula occupying two-thirds and the coracoid one-third. This cartilage is a growth cartilage and allows the glenoid cavity to grow in accord with the head of the humerus. In all the main joints of the body Nature attempts to provide facilities for growth by arranging that a convex surface on one bone shall articulate with a concave surface on another two or three bones, these bones being separated by a growth cartilage. Like all growth cartilages, the intra-articular ones are separated from the adjoining bone by a narrow band of calcified cartilage. It follows that the shoulder-joint of the growing child is much more complicated than that of the adult, in that the glenoid contains two bones, coracoid and scapula, and the articular cartilage overlies growth cartilage, calcified cartilage, and bone.

During puberty the growth cartilage ceases to grow, calcifies, and ossifies. It is at this age, when the scapula and coracoid are becoming firmly knit, that the muscles of the neck and upper limb display active growth. The development of the neck and chest is rapid, as is that of the biceps and triceps. The boy begins to ' throw his weight about ' in more senses than one.

Union of the epiphyses takes place at the elbow earlier than at the wrist and shoulder. Thus fairly heavy muscular work, involving the elbow-joint, such as bench work, is more easily faced by the adolescent than heavy muscular work involving the wrist and shoulder, such as coal-mining, quarrying, plastering and heaving. Any undue load on the musculature of the upper limb, such as frequent and persistent throwing of the cricket ball, or carrying a heavy hod of bricks up a ladder, is to be deprecated; for not only is there danger to the upper limb itself, particularly the shoulder-joint, but there is danger to the upper thoracic and cervical spine, to which are attached the muscles involving violent movements, such as the trapezius, and the muscles involving fixation, such as the rhomboids. Abuse of the upper limb muscles is a threat to the slender upper thoracic spinal column and the enclosed spinal cord.

Pelvis and Lower Limb

The sacro-iliac joint is formed by the auricular surface of the ilium and that of the sacrum. The sacral surface is complex, and consists of the bony costal elements of the first three sacral vertebræ, separated by fibrous tissue and cartilage. The ossification centre for the first and second sacral ‘ ribs ’ is present before birth and that for the third ‘ rib ’ appears soon after birth. At puberty a thin epiphysial bony plate appears in the cartilage on the auricular surface of the sacrum. This bony plate unites relatively late in adolescence and is associated with the late date of union of the first and second sacral vertebræ. Thus the sacro-iliac joint is definitely one in which the age changes and the number of separate elements involved are such as to call for the greatest care in its use. The common practice in secondary schools for girls to spend hours in jumping over a high rope is to be deprecated. Lastly, since the sacro-iliac joint is devoid of a cavity lined by synovial membrane it is, like almost all the vertebral joints, one which can be injured or diseased without pain becoming a cardinal symptom. The fact that pain may be absent in joints which are injured or diseased should be continually present in the minds of physical training instructors.

The hip joint in the child displays the general rule that a joint will be formed if possible between more than two skeletal elements. The convex spherical head of the femur articulates with four other elements consisting of ilium, ischium, pubis, and the triradiate cartilage which separates the three constituent bones (fig. 36). In all animal forms the triradiate cartilage is a true growth cartilage and is separated from the neighbouring bones by thin strips of calcified cartilage. About puberty the growth cartilage ceases to proliferate, calcifies, and ossifies. The ossification is often patchy, and so accounts for the irregular features displayed radiologically in the cartilage by the so-called os acetabuli. Thus, from puberty to adolescence the hip joint is even more complicated than the shoulder joint. The bearing surface in the acetabulum, by reason of the growth at the triradiate cartilage, gives rise to many of the deformities and diseases of the pelvis. The hip joint is often considered only in terms of the head of the femur. The hip bone is forgotten.

Mention should be made of the cartilage at the conjoined ischio-pubis ramus, over which is attached the crus of the penis. Union of the two rami by calcification and ossification of the cartilage takes place at about eight to ten years of age. This area of union is liable to disease, and is particularly liable to injury by falls on the edge of a chair, rail, fence, gymnastic apparatus, or by jumping on to a bicycle. Such injury or disease is difficult to diagnose, and may eventually appear as an abscess in the adductor muscles or an osteomyelitis following an osteo-

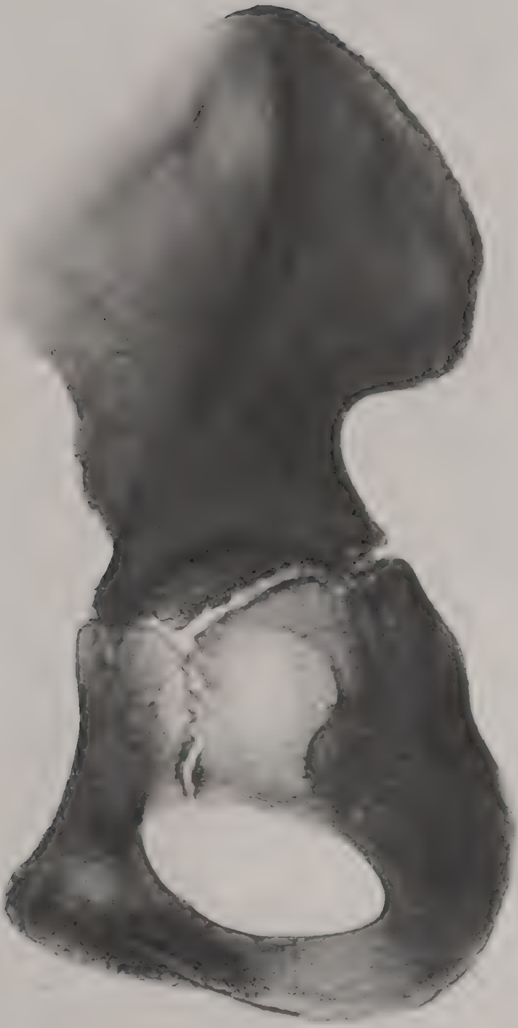

FIG. 36. Radiograph of the hip bone (os innominatum) of a boy of fourteen, showing the triradiate cartilage between the ilium, ischium, and pubis. All three bones and the cartilage are in part involved in the acetabulum of the hip joint.

[*To face p.* 162.

chondritis. Injury of any part of the pelvis may lead to bony union of the sacro-iliac joint on one or both sides.

The first thoracic nerve and ulnar nerve in association with cervical rib, and the fourth and fifth lumbar nerves in association with sacrilization of the fifth lumbar vertebra, and several other anatomical anomalies, call for special care. Space does not permit a detailed account, but one may say that the ulnar nerve and the lower two lumbar nerves are always living dangerously.

Anthropometry

Numerous studies on growth in the child have been made by physical anthropologists, anatomists and pædiatricians. The era of physical anthropometry commenced by Francis Galton in this country reached its maximum in Germany, with Rudolph Martin's Lehrbuch der Anthropologie (1928). Fortunately, in U.S.A. the combination of interests in pædiatrics and anthropology has produced results which are of more moment to the medical man than are the barren statistics. The Americans concentrated on two methods: first, the longitudinal method, in which the course of development of a child is traced over many years; second, the cross-section method involving the study of a large number of children at particular age levels. To these two methods in recent years have been added three new methods based on the study of skeletal age radiographically, of the development of particular systems of the body, especially the urogenital and endocrine, and on the psychological studies of the development of behaviour.

The historical landmarks stand out. These are the monograph on the Growth of the Brain by Donaldson (1895) and that on Growth in the Fœtal Period by Scammon and Calkins (1929). The latter has had as great an influence on pædiatrics as the former had on neurology.

H. A. Harris.

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CHAPTER VIII

PUBERTY

The term puberty is used in the medical literature to describe several slightly different stages of development, and though by derivation the word implies the appearance of hair (*i.e*, secondary sexual hair), this is seldom taken as the sole criterion of puberty. Thus some authors regard puberty as beginning with the onset of menstruation in girls or seminal emission in boys, and covering the period more usually described as adolescence, namely the period after the menarche or establishment of spermatogenesis which is characterized by continued growth and relative sterility. Others, who have carried out metabolic or growth studies on girls, speak of puberty as a fixed point coincident with the onset of menstruation, and refer to the changes immediately preceding the menarche as those of pre-puberty. This has obvious advantages from the statistical point of view, and is justified if it is clearly kept in mind that menstruation or emission represents a single example of a number of interrelated changes, including those of growth, hair distribution, development of the breasts and gonads, breaking of the voice in the male, and changes in psychological attitude. In the present chapter, puberty will be considered as the period of transition from childhood to adolescence, and adolescence as that period between the occurrence of ovulation or spermatogenesis and the attainment of full physical maturity. In this sense, the limits of puberty are clinically less sharply defined. At the onset there is no fixed order in which the first changes associated with puberty occur, whilst at the conclusion the first ovulation is not necessarily coincident with the onset of menstruation, nor the first emission with the onset of spermatogenesis. If an anatomical standard were adopted, puberty might be regarded as the age at which the three constituent bones of the hip, the ilium, ischium and pubis, begin to unite by ossification of the tri-radiate cartilage.

From the legal aspect, however, puberty is the age at which procreation is possible, and in English law is chiefly important in connection with contracting marriage. Marriage is legally permissible at the age of sixteen (Age of Marriage Act, 1929), though both sexes are considered to be minors until the age of twenty-one, and can only marry before that age if certain consents are obtained. In Roman law, the age of puberty was arbitrarily fixed by Justinian at twelve in the case of girls and fourteen in the case of boys. In French law, marriage was at one time permissible at thirteen and fifteen years respectively (Loi du 20 Septembre, 1792), whilst the Code Civile now adopts the standards of fifteen in the case of girls and eighteen in the case of boys.

Age at Onset of Puberty

The great majority of studies on the age-occurrence of puberty have been carried out on girls, using as a standard the age of menarche. In boys, the age of appearance of secondary sexual characters has been related to growth (Ellis, 1947, 1948) or hormonal excretion (Greulich *et al.*, 1942). From such studies certain generalizations can be made. The first, and perhaps most important, is that a wide variation occurs in normal subjects, and that puberty may be established as early as nine years in girls or as late as eighteen in either sex without any pathological cause being found. Secondly, it is generally agreed that girls tend to mature twelve to eighteen months earlier than boys. (This is reflected in the height and weight curves of comparable groups, girls tending to be heavier and taller than boys between the ages of twelve and fourteen and a half years, after which boys again become the heavier and taller.) Thirdly, the appearance of secondary sexual characters, though following no very regular

TABLE 11

Age at Onset of Menstruation

(470 *British Women*)

Years	Number	Per cent.
9 to 10	3	0·6
10 ,, 11	4	0·9
11 ,, 12	35	7·5
12 ,, 13	90	19·1
13 ,, 14	144	30·6
14 ,, 15	129	27·4
15 ,, 16	40	8·5
16 ,, 17	17	3·6
17 ,, 18	6	1·3
18 ,, 19	2	0·4

Average age 13·73 years.

pattern, usually precedes the onset of menstruation by six to eighteen months. Individual differences, however, are again very considerable in both sexes, and the period from the first signs of pubescence to the full establishment of puberty may vary from a few months to two or three years. Godin's studies on French schoolchildren showed that the average age of appearance of pubic hair was twelve and a half years in the case of girls and thirteen and a half in the case of boys, and of axillary hair, thirteen and fifteen and a half years respectively (Laroche, 1938).

Age at Onset of Menstruation. The following figures kindly supplied by Dr. P. M. Bishop, and based on answers to a questionnaire given by 470 nurses of two English hospitals and of the Royal Air Force nursing service, shows the ages at onset of menstruation in a group of healthy women who had passed a medical examination before acceptance for training.

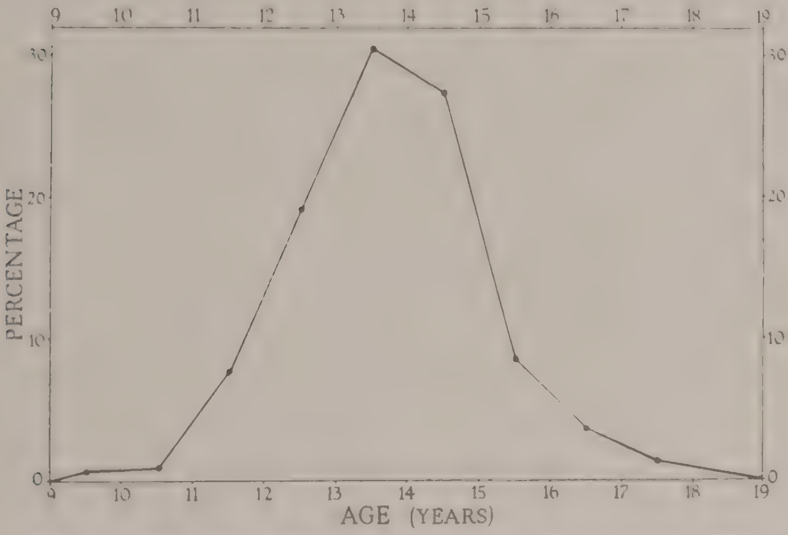


FIG. 37. Distribution curve showing percentage of subjects in whom onset of menstruation occurred in each year of age.

It will be seen that whilst the peak occurs between thirteen and fourteen years, and 363 girls (77·1 per cent.) first menstruated between twelve and fifteen years of age, the spread is considerable, the menarche having occurred between nine and ten years in three cases and between eighteen and nineteen years in two.

Before discussing the various factors which have been thought to influence the age of onset of puberty, or more specifically of menstruation, it is worth quoting the following figures given for the average age of menstruation in other countries (Mills, 1937).

TABLE 12

Age at Onset of Menstruation (Europe)

Country	Town or Province	Author	Date	Number of Subjects	Average age (years)
Scotland	Edinburgh	Kennedy	1933	10,219	15·04 ± 0·01
France	Paris	Vignes	1929	438	13·55 ± 0·05
Holland	Amsterdam	Bolk	1923	1,800	14·06 ± 0·03
Germany	Giessen	Deiterich	1920	770	14·49 ± 0·04
Czechoslovakia	Prague	Dworzak	1935	9,949	14·46 ± 0·01
Norway	—	Skerlj	1935	4,502	14·5 —
Italy	Milan	Torres	1932	246	15·16 ± 0·07
Spain	Asturias	Torres	1932	1,970	15·89 ± 0·03
Finland	Helsinki	Malmio	1919	3,596	15·95 ± 0·04

It will be seen that the average given for France compares closely with that shown above for the group of British women, whilst all the other averages fall between fourteen and sixteen years. If these are compared with the figures quoted for India, Japan, China, and the Philippine Islands, it will be seen that the range is similar, and that the figures do not support the view that menstruation occurs significantly earlier amongst coloured peoples or in hot climates than in temperate zones.

TABLE 13

Race.	Town or Province.	Author	Date	Number of Subjects	Average age (years) at onset of menses
Hindu	India	Curjel	1920	268	14·12 ± 0·07
Mussulman	India	Curjel	1920	140	14·14 ± 0·10
Japanese	Hondo	Yamasaki	1909	1,526	14·73 ± 0·02
Japanese	Kyusyu	Yamasaki	1909	3,085	15·00 ± 0·02
Chinese	Hongkong	Mills	1935	464	15·21 ± 0·05
Filipino	Manila	Mills	1935	636	14·77 ± 0·04
Chinese	Fukien	Maxwell	1920	599	15·44 ± 0·11

Factors thought to Influence Age of Onset of Puberty

Apart from primary disturbance of the endocrine system or chronic disease of any vital organ, there are three main factors which have been held to influence the age at which puberty occurs. These are race, climate and diet. Although a great many generalizations have been made with regard to the influence of all three, it is only when two of the variable factors can be allowed for, and large groups of children studied, that positive evidence can be obtained. It might, for instance, be possible to observe the development of children of different ' races ' living under identical climatic conditions, but any differences in development could only be attributed with any confidence to ' race ' if the two groups were of approximately the same economic level and had adopted the same dietetic habits.

Race. Crew (1930) has discussed the inherent difficulties of assessing the importance of hereditary factors in the age of onset of puberty in human material. Not only is the definition of ' race ' in a manner satisfactory to a geneticist a difficulty of the first magnitude, but the elimination of other factors which may or may not influence the appearance of hereditary characteristics is well nigh impossible. From experiments carried out on mice, Crew concluded that the relative age of attainment of puberty was a genetic character, and stated that experiments then in progress suggested that precocity or early onset was dominant to retardation or late onset. Whilst it is possible that a similar genetic factor may be demonstrable in humans, there is little evidence to suppose that this will necessarily be associated with ' race ' as the term is popularly used. Examples of familial precocity in the attainment of puberty, however, without evidence of gross endocrine abnormality, have been recorded in both sexes (Goldzieher, 1939).

Climate and Environment. It is a popular belief that puberty occurs earlier in children living in hot climates than in those in temperate zones. There appears to be no evidence for this belief, and it is not supported by the figures quoted above. Mills (1937) goes so far as to uphold that early development is actually stimulated by the ' climatic drive ' of the central parts of North America and retarded by extreme cold or tropical moist heat. There is also some experimental evidence that moist heat can retard the growth and development of laboratory animals (Ogle, 1934).

It is probable that the custom of child marriage in India and the practice of confining girl children in purdah in Moslem communities well before the onset of puberty has led to the belief that puberty occurs at an earlier age than is actually the case. Observations on European, Arab and Kabyl children resident in North Africa led to the conclusion that those on a liberal diet showed no significant difference in development from English children comparably fed ; in Southern Italy, the same observation was made on children in easy circumstances, but those whose diet was extremely low in first-class protein (as was frequently the case) tended to show a delay in growth and development up to the age of fifteen or sixteen years.

Season is also held to be a factor influencing the onset of menstruation, Laroche (1938) stating that the peak periods in France are April and August ; it is also commonly stated that menstruation tends to occur earlier in urban than in rural communities. That other social factors such as leisure, fatigue or emotional stimulation may affect the onset of menstruation is also a possibility.

Diet. Asdell and Crowell (1935) showed that by severely restricting the diet of rats, the first œstrus was delayed to the 357th day of life, as compared with the fifty-fifth in the case of normally fed controls. The conclusion that severe dietetic restriction can delay puberty has been reached by different observers in several of the occupied countries of Europe during the war years. In Belgium, this was confirmed from the menstrual histories of older girls attending school in the working-class commune (Ellis, 1945). The diet during the occupation of Belgium was principally lacking in first-class proteins and fat, and it is probable that it is lack of the former which is principally responsible for retardation of puberty. (Experimental work indicates that deprivation of vitamin E affects fertility rather than onset of puberty.)

Pathology of Delayed and Precocious Puberty

Whilst the normal age-range of onset of puberty is very wide, certain pathological conditions may result either in delayed or premature development. The tendency is usually to seek a pathological explanation for cases which fall within the normal range rather than to overlook gross endocrine or other disturbances (which are for the most part rare), but mention will be made of the more important pathological conditions affecting puberty.

Delayed Puberty. This may result from chronic disease of almost any one of the essential organs. Classical examples are renal infantilism and cœliac infantilism, in both of which growth as well as sexual maturity is delayed. Cardiac and hepatic infantilism may also occur, whilst more generalized infection (congenital syphilis, leishmaniasis, malaria and tuberculosis) will sometimes retard growth and development.

Three more or less clearly defined endocrine types are recognized :—

(1) *Hypogonadal.* Complete destruction of the gonads by disease or trauma will of course inhibit sexual development and appearance of secondary sexual characters. Growth, however, though less rapid than in children developing normally, may continue over a longer period, the final height of castrates then

being above the average. A much more common and important cause of hypogonadal delay in the establishment of puberty in boys is maldescent of the testis. When this is bilateral, and the testes remain within the abdominal cavity, it is likely that spermatogenesis will be inhibited, and that secondary sexual characters will be incomplete, late in appearance or altogether absent. (The types of maldescent of the testicle and indications for treatment have been fully discussed by Bishop, 1945).

(2) *Hypothyroid infantilism* is best exemplified in untreated cretinism, in which sexual, somatic and mental development are all retarded. Minor degrees of hypothyroidism may also be associated with pituitary infantilism.

(3) *Hypopituitary infantilism* may date from birth or occur secondarily to lesions of the anterior pituitary, the result of tumours or acquired disease. It may be associated with extreme retardation of growth or with obesity which tends to assume a girdle distribution. The diagnosis of 'Frohlich's syndrome,' or adiposo-genital dystrophy, however, is frequently made incorrectly in cases of simple obesity due primarily to exogenous factors.

Delayed involution of the thymus, though sometimes seen in cases of infantilism, is probably secondary, and it is doubtful if a true thymic infantilism occurs.

In addition to the above types, the term 'idiopathic infantilism' is applied to those cases, which may be familial, in which no primary lesion of an endocrine or other organ can be demonstrated.

Precocious Puberty. Apart from familial and idiopathic cases, precocious puberty due to endocrine or other lesions is rare. It may, however, arise from the following causes :—

(1) Tumours of the pineal, usually associated with hydrocephalus and possibly causing secondary effects on the pituitary or mid-brain. This syndrome occurs only in boys.

(2) Hyperplasia or tumours of the adrenal cortex. (In girls, these produce virilism, *i.e.*, masculinization, with hypertrophy of the clitoris and hirsutes rather than true precocious puberty.)

(3) Tumours of the testicle or tumours or cysts of the ovary (though in at least some cases the appearance of multiple granulosa-cell cysts of the ovary has suggested a secondary rather than a primary lesion).

(4) Tumours and inflammatory conditions of the mid-brain or infundibulo-tuberal region, the majority of cases having been described in boys.

(5) Sequelæ of icterus gravis neonatorum (in girls), when

sexual precocity is associated with osseous dystrophy, pigmentation, and in some cases hyperthyroidism.

The great variety of lesions which may result in delayed or precocious puberty illustrate the close inter-relation existing between the component parts of the endocrine system, and the fact that sexual development is not an isolated phenomenon, but one affecting the whole endocrine balance.

Physiology of Puberty

Apart from the emotional development and personality changes which take place at puberty, this period is characterized by four inter-related features :—

(1) Increase in height and weight and transition toward adult proportions.

(2) The appearance of secondary sexual characters, and early sexual development.

(2) A generalized readjustment of endocrine balance.

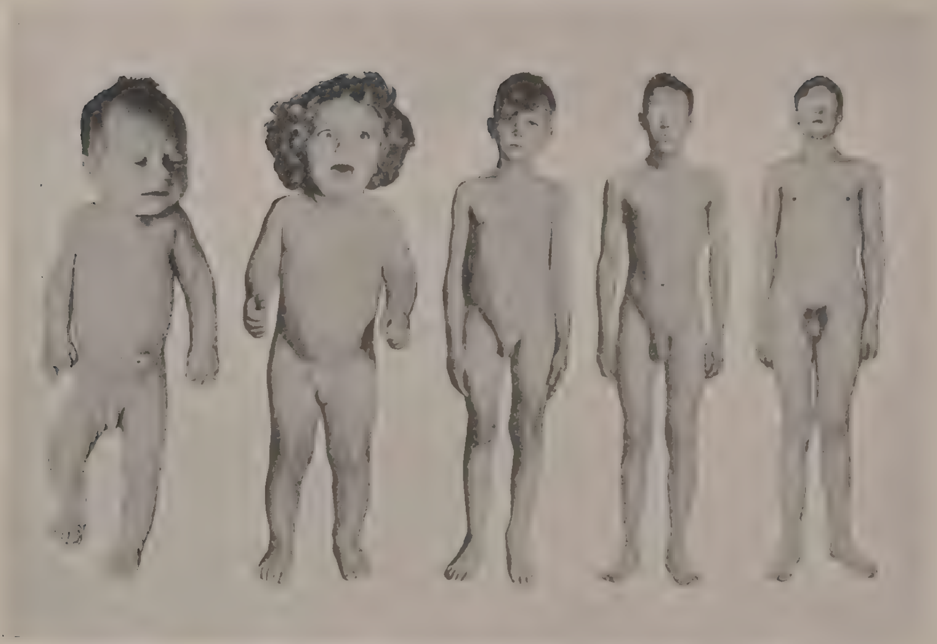
(4) A process of maturation affecting the whole organism, and accentuating the difference between the two sexes.

The conception of puberty as a transition period rather than the sudden attainment of maturity should be kept in mind; within a period of six months to two years the individual will change more radically than at any other period of development save that of early infancy, but even so the transition period lasts sufficiently long to provide emotional and physical problems peculiar to this age. The rapidity of maturation throws an exceptional strain on the whole organism, and it is at this age that a latent weakness of constitution is often brought out, *e.g.*, decompensation of a congenitally deformed or rheumatic heart, or lighting-up of a tuberculous focus. Defects of posture may become apparent, particularly when muscular development has not kept pace with growth in height. Whilst many children pass through puberty with a minimum of disturbance of physical well-being, others suffer from a variety of symptoms of which painful self-consciousness, vaso-vagal symptoms, fatigue and gastro-intestinal upsets are the most common. It follows that children reaching puberty require particularly tactful and sympathetic handling, and unobtrusive supervision; the parent or teacher has to steer a middle course between undue fussing over symptoms which are purely temporary and the natural outcome of development, and of making too high demands on both intellectual and physical performance at a time when much of the child's available energy is devoted to growth. A liberal diet, including milk and animal protein, is particularly necessary at this age; a great increase in appetite is the general rule, and as long as this is not associated with obesity, should not be restricted unnecessarily.

In the case of girls, the question often arises as to whether they should play compulsory games or bathe at the time of menstruation. It is undesirable that any hard and fast rule should be laid down ; in some cases, girls find that they can take active exercise at these times without inconvenience, and if so they should not be taught to regard menstruation as a time of invalidism. In other cases, where menstruation causes some genuine disability, games should not be enforced or encouraged. There is of course no contra-indication to baths during menstruation, as is sometimes believed. It is highly desirable that some instruction in the physiology of puberty, preferably linked with the teaching of biology, should be given to children before this stage of development is reached. If it is left until puberty has already begun, it is usually found more difficult to establish an objective atmosphere in which questions can be asked and personal problems discussed when they arise.

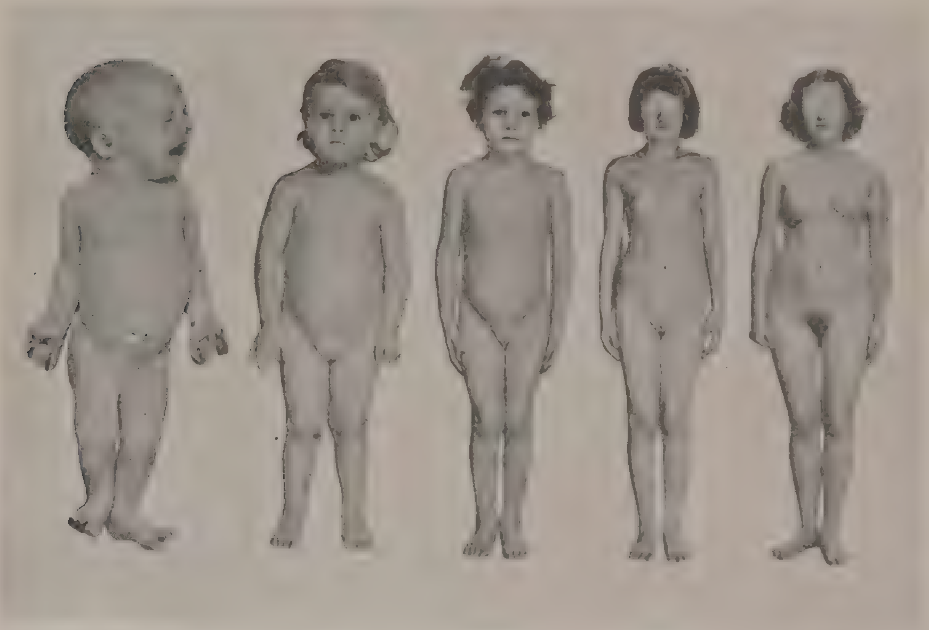
Growth. From what has been said in the preceding chapter, it will have been seen that even during childhood growth is not a uniform and regular process involving height and weight equally at all periods. The onset of puberty, or pre-puberty, is characterized by an acceleration of growth, and studies of children's growth curves have shown that the early or late onset of puberty is to some extent predictable by this prepuberal acceleration. Thus it has been found that pubescent children are both heavier and taller, on the average, than nonpubescent children of the same ages. It is also found, however, that the early onset of puberty is associated with an early slowing-down of growth in height, and after the age of sixteen, girls who had not menstruated were found by Stone and Barker (1937) to be taller than those in whom the menarche had occurred. There is also some evidence that the adult height of individuals reaching puberty early is slightly less than that of those in whom puberty occurs later, and that the broad 'pyknic' type of child tends to mature earlier than the child who is slender.

Proportions. The change in body-form and proportions associated with puberty is well seen in the following figures (figs. 38 and 39), in which photographs of children from birth to adolescence have been reduced to the same height. It will be seen that whereas in the newborn the head represents approximately one-quarter and the legs three-eighths of the total length, in adolescence the head represents one-seventh and the legs one-half. In the case of boys, the slenderness of both limbs and trunk are very



Newborn. 20 months. 7 years. 13 years. 16 years.

FIG. 38. Relative proportions of boys from birth to adolescence.



Newborn. 2 years. 4 years, 11 years. 14 years.

FIG. 39. Relative proportions of girls from birth to adolescence.

noticeable at the age of thirteen (onset of puberty), whilst at sixteen considerable filling-out and muscularization has taken place. In the case of girls, the same change in the proportions of head, trunk, and limbs have occurred, but at the age of eleven (onset of pubescence) there is already a tendency to increased width of the hips, whilst at the age of fourteen the characteristic feminine contour has been attained.

The face also develops rapidly during puberty in both sexes, the growth of the nose, maxilla, and mandible changing the appearance of the round, button-nosed child to that more characteristic of the adult.

Appearance of Secondary Sexual Characters

Distribution of Hair. The appearance of pubic hair is among the earlier signs of onset of puberty, though it may be preceded by some degree of genital development. Hairs first appear in boys at the root of the penis, and in girls on the labia majora, gradually covering a triangular area over the pubes, the apex of the triangle directed downward and the base lying horizontally. With the attainment of adolescence, axillary hair appears also (the time of appearance varying considerably in different individuals), and in the case of boys the pubic hair begins to assume the male distribution, *i.e.*, a central line of hair running from the umbilicus to the midpoint of the base of the pubic triangle, with more sparsely distributed hair over the lower abdomen, groins, perineum, and anal region. At this stage there is a marked difference in the growth of facial and body hair in the two sexes, the growth of hair being limited in girls to the axillæ and pubis, but in boys affecting the thighs, outer aspect of the forearms, upper lip, and finally the beard area. In boys also the eyebrows become heavier and tend to meet in the mid-line, whilst hair continuous with that of the scalp tends to grow down on to the cheeks.

Breast Development. This usually occurs as an early sign of puberty in girls, and may be present for some considerable time before menstruation is established or whilst pubic hair is minimal in amount and limited to the labia majora. It is usually accelerated when menstruation has occurred, and enlargement of the nipples is noticeable at about this time.

In boys, it is relatively common to see slight breast development (gynæcomastia) during puberty: it was observed in 32·1 per cent. of boys under sixteen graded as adolescent, in 12·9 per cent. graded as 'pubescent,' and in none graded as 'prepubescent' (Ellis, 1946). This should be distinguished from deposition of fat over the breast area, which may give a false impression of breast development but which is part of a more general fat deposition and often results in retraction of the nipples. In true gynæcomastia, a nodule of mammary tissue is palpable below the nipple ; it is sometimes unilateral, and may be tender. Very occasionally, a small amount of colostrum is secreted. The gynæcomastia is almost always of slight degree, disappearing spontaneously, and requiring no treatment. The cause is thought to be a temporary imbalance of androgen : œstrogen ratio (see below), but Weber (1944) and others have emphasized the

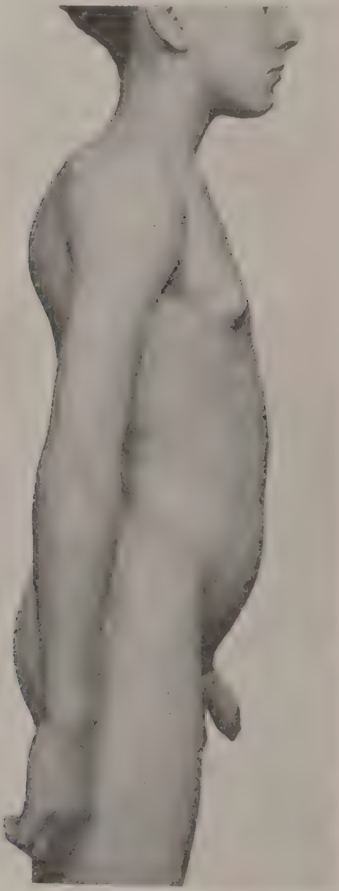


FIG. 40. Gynæcomastia associated with puberty in a boy aged 13½ years.

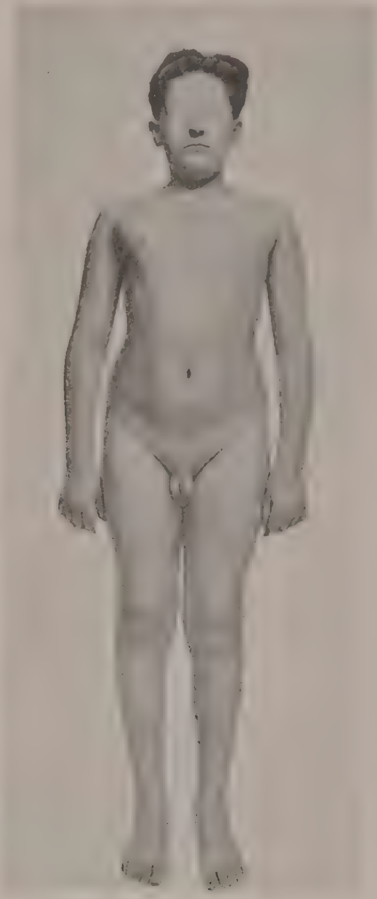


FIG. 41. Fat deposition of girdle-distribution giving a pseudo-feminine contour in a boy aged 13 years (onset of puberty).

necessity of recognizing individual differences in constitution, *i.e.*, the ground in which the hormonal seed is sown, in interpreting the individual differences to endocrine stimulation.

Some enlargement of the nipples and pigmentation also occur in boys during the latter phase of puberty.

Growth of the Larynx. The rapid growth of the larynx which takes place at puberty results in the deep or ' broken ' voice of the male, and some change in the quality of the voice in the female. Prominence of the Adam's apple, however, is a privilege peculiar to the male.

Breadth of the Hips and Fat Distribution. Owing to the inherent difficulties in obtaining accurate measurements of the bony pelvis during life, most of the published observations on the size of the male and female pelvis at puberty must be interpreted with reserve. There is at this period considerable deposition of fat around the hips in the case of girls, which is largely responsible for the characteristic female contour (see figs. 38 and 39).

It is, however, not uncommon in boys at the onset of puberty to see a very similar girdle distribution of fat, giving rise to a pseudo-feminine appearance (see fig. 41). If this precedes obvious genital development, it is liable to be mistaken for evidence of pituitary deficiency. The literature contains numerous reports of dramatic results following endocrine therapy given to fat boys of thirteen or fourteen, who reached puberty shortly afterwards in spite of the therapy given. In many cases, this type of girdle-obesity is transitory, and disappears with the establishment of adolescence. But when the obesity is more generalized and the weight-for-height excessive, the condition requires treatment by diet (limitation of carbohydrate intake and fat) if a more permanent condition of obesity is to be avoided. This constitutes a real danger, and careful judgment must be exercised in distinguishing between the relatively slight girdle distribution of fat which is innocuous and the more generalized obesity which is the result of over-eating.

Whilst the same danger of permanent obesity dating from puberty applies to girls, the physiological deposition of some degree of subcutaneous fat at this age is more characteristic and persistent ; it gives rise to more rounded contours of both the trunk and limbs, and less visible muscularity, than in the case of boys. It is occasionally found, however, that there is an actual diminution of subcutaneous fat in pubescent girls, of peculiar distribution, simulating a mild degree of lipodystrophia progressiva, *i.e.*, affecting the face and upper part of the thorax only.

Skin. The sebaceous and apocrine sweat glands, particularly of the axillæ and genital and anal regions, develop considerably during puberty and give rise to a characteristic odour ; the change is more marked in the male. Enlargement of the pores at the root of the nose and the appearance of comedones and acne, whilst liable to occur in either sex, are considerably commoner in adolescent boys, since the underlying skin changes are the result of androgenic activity. Thus in a series of boys aged eleven to sixteen years, comedones of the face were observed in 19·7 per cent. of those classified as ' prebubescent,' in 41 per cent. of those graded as ' pubescent,' and 76·2 per cent. of those considered adolescent (Ellis, 1946). A roughening of the skin in certain areas (particularly over the outer aspects of the thighs and upper arms), associated with a mild degree of follicular keratosis, may be seen in both sexes at this age, but again is commoner in boys.

Sexual Development and Endocrine Balance

As already indicated, sexual development is only one element in a profound shift of endocrine balance at puberty. In fact, it is not yet possible to say with certainty in which part of the endocrine system the stimulus to sexual development is initiated. The view has been put forward (Kurzrok, 1937) that the onset of puberty occurs when the gonads have reached a sufficient degree of maturity to respond to gonadotrophic stimulation, but whilst this may prove to be a correct conception, a clear relationship between cause and effect is not at present established. Greulich *et al.* (1942) consider that ' a likely mechanism for the initiation of puberty is a gradual increase in pituitary secretion, combined probably with an increasing sensitivity of the gonads to the hormone.'

From what has been said with regard to the pathological causes of delayed and precocious puberty, it will be realized that a primary disturbance of almost any part of the endocrine system may affect sexual development. Conversely, evidence of a generalized readjustment of endocrine balance at puberty is afforded by comparing the physiological changes observed clinically during this period with the changes seen in diseases of particular endocrine organs. Thus the girdle distribution of fat referred to above is similar to that seen in Frohlich's syndrome ; the rapid growth of the extremities (enlargment of the hands and feet often being very obvious in the case of boys) and growth of the nose and mandible are comparable to the changes in acromegaly ; the appearance of hirsutes is seen in hyperplasia of the adrenal cortex; whilst thyroid enlargement and tachycardia, both often observed at puberty, are also features of Graves' disease.

The hormones known to be concerned in the establishment of puberty are: the gonadotrophic hormone of the anterior pituitary, the growth-stimulating hormone of the anterior pituitary, the hormones of the ovary and testes, corticosterone, and thyroxine. Corticosterone, which is one of the hormones of the adrenal cortex, resembles in structure and physiological action the androgens of the testicle.

Catchpole and Greulich (1940) carried out day-to-day estimations of hormone excretion on a series of young girls and found that before puberty there were long periods in which no hormonal excretion could be detected, with occasional low positive values for short periods. These positive values increased in frequency and amount with the approach of puberty. Greulich *et al.* (1942) were unable to demonstrate the presence of gonadotrophic hormone in the urine of boys under eleven years of age, and obtained only two positive minimal results out of some forty tests performed before the thirteenth year.

With the establishment of ovulation, a cycle of complex hormonal interaction is initiated, involving the follicle-stimulating hormone of the anterior pituitary, the follicular hormone of the ovary, the luteinizing hormone of the anterior pituitary, and the hormone of the corpus luteum (progesterone). Whilst discussion of the hormonal mechanism of the adult menstrual cycle lies outside the scope of this section, it should be mentioned here that during puberty menstruation may, and frequently does, at first occur in the absence of ovulation and luteinization, the bleeding sometimes in such cases being excessive. On the other hand, cases of pregnancy have been described occurring before menstruation has been initiated, indicating that ovulation may in some instances precede menstruation. Many girls establish a regular menstrual cycle following the first occurrence of menstruation, but in other, and apparently normal, cases it takes some months for regularity in periodicity, duration, and quantity to occur. Gross irregularities or excessive loss after the first menstrual period, however, are likely to call for investigation and treatment.

The thyroid enlargement which commonly occurs at puberty, and which in girls is closely related to the menstrual cycle, is stimulated by the thryotrophic hormone of the anterior pituitary.

Genital Development. In boys, either the penis or testicles may first show evidence of enlargement, growth of both organs continuing over a period of one to two years or more until adult proportions are reached. Frequent erections are common during the period of development, and when spermatogenesis is established, nocturnal emissions occur. These may be quite irregular at first, but later there is often a tendency to establish some periodicity. There is an increased secretion of smegma during puberty, which accumulates beneath the prepuce unless retraction of the prepuce and regular washing of the penis is practised. The prostate, which has barely doubled its weight between birth and later childhood, enlarges rapidly during puberty and produces prostatic secretion, whilst the tubules increase in calibre and branch distally (Scammon, 1923). The seminal vesicles enlarge at the same time. The seminiferous tubules become active during the period of enlargement of the testes, and spermatogenesis is established at approximately the same time that the pubic and body hair begin to assume the male distribution. The sperm count is at first low, and boys during early adolescence are relatively or absolutely sterile.

In girls, the appearance of the external genitalia is altered by the enlargement of the labia majora, which cover the vaginal orifice ; the latter tends to be directed downward. Fat is deposited over the mons veneris. The labia minora also enlarge, and Bartholin's glands become active. The clitoris hypertrophies and becomes erectile. Rapid growth and development of the uterus occurs at the same time, though the uterus does not assume adult proportions until later. Cyclical uterine discomfort may occur for one or two months before menstruation is established. The ovaries nearly double their weight between the ages of twelve and fifteen years (Scammon, 1923). Simpkins (1932) describes two types of follicle in childhood, the primordial, which lie in the primordial cortex and gradually degenerate during childhood until they finally disappear with the onset of sexual maturity, and the primary, which are more or less constant in number from birth to sexual maturity, when the number begins to increase. Three stages in the development of the follicles with the approach of maturity have been described : (1) incomplete maturation, (2) complete or almost complete maturation without ovulation, which may be accompanied by non-ovular menstruation, and (3) full maturation with ovulation, followed by the normal ovular menstrual cycle.

The vaginal flora in childhood and during puberty has been studied by Soeken (1926), who found that until the first signs of puberty appeared there was a predominance of cocci, and that a pure flora of vaginal bacilli was never encountered. The change to a flora consisting predominantly of vaginal bacilli occurred rapidly (usually within a week), after secondary sexual characters had appeared, but usually before the first menstrual period. In no case was a subsequent return to a coccal flora observed.

Basal Metabolism

Although some of the observations are conflicting, most authors agree that the basal metabolism is highest in infancy and early childhood and falls throughout childhood. At puberty, however, there appears to be a temporary increase, or delay in the decrease, before the adult level is reached. Topper and Muller (1932) found that this temporary increase reached its maximum at approximately the time of onset of menstruation in girls and sexual maturity in boys, but that there was no uniformity either in the height or duration of the increase ; Molitch (1935) could demonstrate no correlation in boys between body build and oxygen absorption. Bruen (1933) has described the findings at puberty as the mathematical resultant of a fundamental decrease of basal metabolic rate with age and a superimosed cyclic acceleration, which he regards as an independent metabolic acceleration.

Cardiovascular System

The occurrence of vaso-vagal disturbances at puberty is so common as to indicate an instability, which, when it occurs, can hardly be considered outside the range of normal. The term ‘ puberty heart ’ is sometimes applied to the association of tachycardia, flushing or palpitations, and a soft basal systolic murmur, with or without thyroid enlargement. The occurrence of fainting attacks, though often observed for the first time at puberty, cannot be dismissed with equal confidence, since these may sometimes be a prelude to true epileptiform attacks later. The blood pressure may show variations with the periods of menstruation, the commonest being a tendency to rise when bleeding commences, followed by a fall. Sinus arrhythmia is also more conspicuous in girls than boys at puberty.

Nylin (1935), who made an intensive study of the circulation during puberty, found no evidence of a constant increase of pulse rate at this age, and described the normal reaction as a successive decrease during the whole of development. Average values showed a fall from 82 beats per minute at ten years to 73 per minute at fifteen years. The corresponding figures for the systolic and diastolic pressures in the two age groups were 96·3/64·8 and 104/66·6 mm. Hg. ; no provable puberty reaction could be demonstrated. The same author found that the heart volume and stroke volume showed a parallel and rapid increase during the puberty maximum, corresponding with the increase in surface area of the body.

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CHAPTER IX

INTELLECTUAL DEVELOPMENT

The Nature and Measurement of Intelligence

Introduction. As compared with other animals, man is peculiar in that his instinctual habits are all extremely complex. His reactions are developed only after long processes of development and conditioning. Behaviour patterns, such as walking, which are spontaneous in animals, have to be acquired in man. The child has to learn innumerable performances, which in later life become habitual, such as talking, dressing, maintenance of personal cleanliness and control of desires and emotions in a way which is acceptable to the social group of which he is a member. In civilized communities, a child is expected to undergo a training known as scholastic education, designed to equip him both for economic usefulness to the community and for competition with his fellows. Individuals are found to differ in very marked degrees in their abilities to react both to the elementary learning of habit patterns and to scholastic education.

Mental Measurement. Many methods have been devised for measuring the different degrees of learning capacity which are observed in different individuals. The inherent complexity of the problem is accentuated by the fact that we attempt to measure something which is continually growing. A general principle commonly employed is first to establish by observation a scale of norms for each particular age and then to compare any given subject with this standard. We can then tell roughly how much the child is retarded or advanced in respect of any chosen character. Norms for scholastic achievement are accurately known for the period between the ages of five and fourteen years. The accomplishments of average children of each age are standardized in the test originally devised by Binet and Simon, subsequently revised by Terman and carried down to the age group below three years by Merrill. A revision suitable for English schoolchildren was made by Burt and a modified version suitable for rapid testing, recommended by Shrubsall and Williams, has been widely used in England. Activities typical of normal children from birth to two years have been listed by Gesell. A subject who passes the tests suitable to the age specified is said to be of normal intelligence. In the Binet tests, an achievement is considered normal for a given age, if two-thirds of children at that age can do it. There are many available tests which do not imply special scholastic or cultural backgrounds and some of these are considered to be better measures of intelligence than those of the Binet type. With the exception of the Porteus maze test, they are not usually scored in terms of mental age but rely on other statistical devices, such as centile ratings or other measures of dispersion from the normal or average score. By such devices, the same degrees of advancement above the normal level or retardation below it can be ascertained at different ages.

Different Types of Tests. Tests are divided into verbal and non-verbal types. Some non-verbal tests have been termed 'performance tests' because they involve moving blocks of wood about or fitting objects into the correct places. A favourite type of performance test is an elementary jig-saw puzzle known as a form board. Performance tests for infants have been devised sometimes with extremely elementary apparatus. Obviously, verbal tests are only suitable for older children. The Binet test is largely, but not entirely, verbal. A test of less scholastic character, which contains both verbal and non-verbal elements, is the Otis. It has the advantage of being applicable simultaneously to groups of children. The junior Otis test is non-verbal in character. The subject has to recognize relationships between objects represented in pictures. There is a senior and an advanced Otis test; both of these contain much verbal material. It has been found technically difficult to construct non-verbal tests for older children or adults though the difficulty has been partly overcome by the use of visual analogies in the form of patterns which the subject has to complete. A widely used form of visual analogy test is the Progressive Matrix series. In clinical work, it is advisable always to use both verbal and non-verbal material. Subjects who are weak in verbal ability sometimes show surprising results when tested with form-boards, mazes or non-verbal analogies. A series of performance tests, which can be used for children handicapped by deafness as well as for those with normal senses, has been compiled and standardized recently by Drever and Collins.

The Intelligence Quotient. Growth in mental ability is approximately linear and regular during most of the period from birth to adolescence, that is to say, it starts at zero and proceeds by equal steps for equal periods of time. If a child is found to be normal on the tests at one point, it is assumed that it will continue to follow the normal line of development. The further assumption is very generally made, that the percentage of chronological retardation or advancement found for any child is constant. The percentage of chronological deviation is the 'intelligence quotient' and is expressed as 'mental age multiplied by 100, divided by chronological age.'

It will be easily perceived that the concept of intelligence quotient or I.Q., as a measurement of mental capacity, has serious limitations :

(i) The I.Q. can only be applied with reasonable accuracy in the age period during which mental growth is approximately linear, that is, up to fourteen years. After this, the growth of intelligence tends to slow down. It is uncertain when the maximum is reached but it may be at about twenty years. During the period after fourteen years, knowledge and experience can increase. Scores on tests which imply accumulation of information (vocabulary or general knowledge) go on getting better in adult life. Nevertheless, intelligence quotient is a concept invalid for adults.

(ii.) The I.Q. is strictly only justifiable as a method of interpreting the results of tests which are scored in terms of months and years of age; *i.e.*, the Binet test or its revisions and the Porteus maze test.

(iii.) The type of intelligence measured by the Binet I.Q. is orientated towards a particular cultural and educational pattern, which is current in Western civilization. Intelligence quotients can only be rightly compared for children brought up in similar cultural environments and with similar opportunities.

Definition of Intelligence. Intelligence can be defined in various ways and perhaps one of the most acceptable concepts is that of capacity to react efficiently in new situations.

According to the views of Spearman, intelligence is a truly quantitative characteristic, like mass or horse power, which individuals possess in varying degrees and which is expressed through various channels of performance. Some measurements, like speed of reaction, are poor measures of the basic quantity while other test measurements, like those involving visual perception of space, are considered good indices. Spearman's theory does not work out perfectly in all details and encounters special difficulties when the subject's innate capacity is masked by disease but, within the limits of the normal population, it gives a fair approximation to the true state of affairs and has the advantage of simplicity.

Special Aptitudes. Most tests of mental function do not directly measure intelligence but something else, which is correlated in some near or remote degree, with intelligence. Tests can be devised to measure special capacities. Thus, a valuable battery of tests collected together by Seashore measure the suitability of a child for musical training. Mechanical aptitude has been investigated with special methods by Baker. Examinations by tests have been compiled for a great number of careers including such professions as medicine. Most of the work on these lines has been done in the United States and it has been found that the mere familiarity with the vocabulary of a trade or occupation is easy to estimate and has fairly good predicative value for success or failure in that occupation.

Vocational Guidance. Advice of a general character concerned with the prospects of success of a given individual in different types of occupations can be given on the basis of a knowledge of scholastic achievement and intelligence. This procedure is known under the general heading of vocational guidance. The positive inclinations of the child or adolescent have to be carefully weighed against his capabilities as shown by his scholastic examination results in different subjects. Those studies closely related to the proposed trade or professional activity are obviously of prime importance, such as arithmetical ability in a candidate for accountancy, aptitude for art in a candidate for commercial design or linguistic facility in a candidate for journalism. The range of intelligence which is suitable in each type of employment must also be compared with the candidate's known performance. By attention to this particular, serious disappointment at a later date can be avoided. For example, it has been recommended that subjects with I.Q. below about 115 should not be advised to take university courses or other forms of higher education because of the danger of their failing in final examinations. Estimates of the ranges of intelligence required in occupational groups have been made by Cattell, but there are divergences of opinion. Very roughly, the professional and directive occupations require an I.Q. above 115. Skilled labour needs an I.Q. between 85 and 115. Unskilled labour is efficiently carried out by individuals with I.Q. 70 to 85 and below 70 casual labour as a source of livelihood is possible. Many subjects, however, have special skills, in which their performances rate much higher than would be expected from a knowledge of their scholastic test results. Conversely, failure on tests may not always be due to lack of intelligence. In most tests there is an element of luck which may determine whether or not the subject 'catches on' to the idea involved. To obviate this, modern American technique allows for a practice or training period before the test begins. Even this precaution cannot make allowance for poor scoring on tests by subjects suffering from temporary illness or permanent sense deprivation. Many authorities in England still hold that test results are essentially unreliable and prefer to base clinical judgments as well as vocational prognosis upon personal interview and detailed study of a candidate's history.

The Range and Distribution of Mental Capacity

The Distribution in the General Population. In any given population, individuals are found to differ enormously from one another with respect to intelligence. The scatter is much more marked than it is, for example, in the case of stature. To measure the degree of dispersion in any distribution, statisticians use the

FREQUENCY DISTRIBUTION OF INTELLIGENCE MEASURED BY BINET INTELLIGENCE QUOTIENT

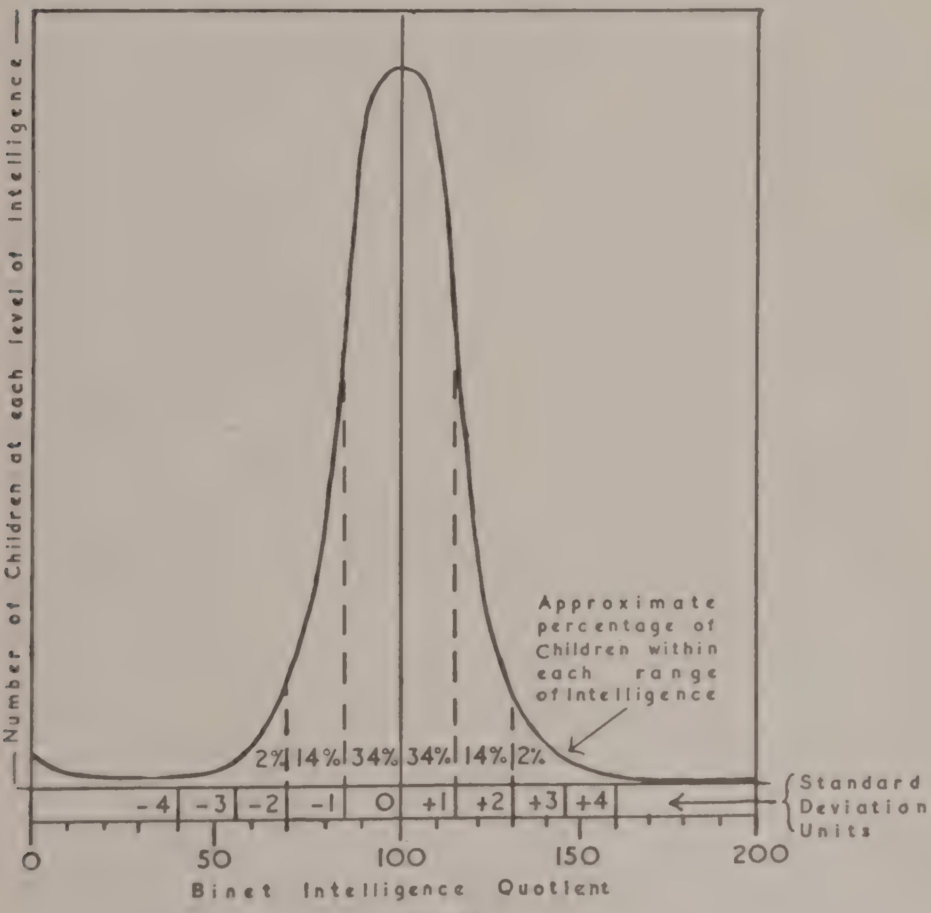

FIG. 42.

concept of the standard deviation (σ). This quantity defines two points on any scale of measurement, one on either side of the mean value. In the 'normal' type of distribution, to which most biological data approximately conform, almost 16 per cent. or 15·86 per cent. of the cases fall below the point situated one standard deviation below the mean (-1σ) and another 15·86 per cent. of the cases lie above a point situated one standard deviation unit ($+1\sigma$) above the mean. Furthermore, 2·27 of the cases lie below the limit of two standard deviations below the mean (-2σ) and another 2·27 lie beyond the limit of two standard deviations above the mean ($+2\sigma$). These relationships are shown in fig. 42, where the distribution of intelligence scores on the Binet test in the general population, based mainly on the observations of Roberts, is depicted. The chief points to observe about this distribution are as follows :—

(*a*) The distribution is continuous. There are no natural lines of demarcation, which separate the normal from the subnormal or from the genius. This continuity, which was first demonstrated clearly by Pearson, makes the exact definition of mental deficiency by means of intelligence an arbitrary one.

(*b*) The distribution is well expressed by the 'normal' curve of error. In the case of the Binet intelligence quotient, the standard deviation is found to be 15 points. For stature, at any given age, a similar curve is obtained, but the standard deviation, for example, of children aged ten is only about $2\frac{1}{2}$ inches or 5 per cent. of the mean total stature of 50 inches. Fig. 41 shows that nearly 16 per cent. of all children have scores below the I.Q. of 85 and about 2 per cent. of these have I.Q. less than 70. It is usual to consider that any subject, whose score is below the point of 70 (-2σ), is mentally defective. According to the result of a survey made by Lewis in 1929, in which the definition of mental defect was based on other considerations than mental tests, 2 per cent. of children of school age were found to be defective. This shows that there is general agreement about the proportion of the population in this category.

(*c*) There are two important irregularities in the distribution of intelligence.

(i.) In the region between I.Q. 0 and I.Q. 50 the curve is not 'normal.' There are too many cases of severe or low grade defect to agree with the shape of a 'normal' distribution. Actually the 2 per cent. in this region is divided in the proportions, five idiots; twenty imbeciles; seventy-five feeble minded. In a 'normal' distribution there would be hardly any idiots at all. Moreover, if we were to take children at birth or in early infancy instead of at school age, we should see this effect much exaggerated. About 1 per cent. of all births result in deformities of the nervous system, anencephaly or hydrocephaly, which are so gross as to make idiocy certain if the child survived. The elimination of these cases in early life leaves the distribution almost normal at school age.

(ii.) Comparison of intelligence in boys and girls shows that, with respect to the Binet test and most others, boys are more variable than girls though the mean values are the same for the two sexes. Thus, there are more boys at the extremes of both upper and lower ends of the scale. More boys than girls have high scholastic ability and there are more male than female idiots.

Interpretation. The understanding of the distribution of intelligence is of practical importance in many fields. We can tell how many children can be expected to fall within any given limits. The continuity of the curve and its symmetry indicate that most low scoring children are not abnormal but an integral part of the general population. The low scorers are, moreover, balanced by an equivalent number of high scorers, who, each in their own way, are equally exceptional. Only in the very low scoring group below about the level of I.Q. 50 are we obliged to regard most of the cases as definitely pathological deviations.

Hereditary Factors. From the genetical point of view, the distribution of intelligence is also very significant. Within the whole range from about 55 to 145 or -3 to $+3$ standard deviation units there is no suggestion of segregation into a few distinct types. The genetical factors involved must be very numerous. In so far as general mental ability is inherited, the manner of its inheritance is multifactorial. Surveys of the relationship between capacities of parents and children and of brothers and sisters have supported this view. The known facts can be expressed by saying that, if a sufficiently large number of instances be examined, the mean level of intelligence of the children in each family (though these can vary widely among themselves), is the same as the mean level of intelligence of the father and the mother. There are notable exceptions to this rule, which are specially to be found among families which contain a member of the idiot and imbecile group. In some of these cases the cause is a single rare Mendelian recessive factor and in such instances the parents and three-quarters of the brothers and sisters are likely to be of average intelligence.

Environmental Influences. The effects of environment on the intelligence are widespread and incompletely understood. Environment in this sense begins in the parental stage of development, where malnutrition, infection or antigenic incompatibility may retard growth, and it continues to exert an influence through physical and psychological agencies throughout childhood. Though it has been authoritatively asserted, on the basis of statistical studies of variability of intelligence in brothers, sisters and twins, for example, that 80 per cent. or more of the variability of intelligence is due to hereditary causes, individual cases of mental retardation may be found where environmental influence is by far the more significant factor, as in the case of encephalitis in childhood or serious cranial injury.

Normal Standards of Intellectual Development

Fœtal Behaviour. In recent years a great deal of information has been tabulated concerning the age at which the different mental processes develop in the human subject. Observation has also extended to the prenatal period. Spontaneous movements of a worm-like character were observed by Minkowski in a fœtus about eight weeks old and, from this point onward, external stimulation can elicit responses although quickening is not felt by the mother until towards the fifth month. In the sixth month many of the deep tendon reflexes are established and in the seventh month cutaneous reflexes begin to appear. Peiper tested the sense reaction of the fœtus *in utero* and reported that definite movements could be induced by the sound of a motor horn but the correctness of his explanation is open to some doubt.

Neonatal Behaviour. Crying is one of the most characteristic reaction patterns which is present in the infant from birth. Tears do not accompany the activity usually, however, until after three or four weeks have elapsed. Yawning, sneezing, hiccoughing, stretching, vomiting, salivation, urination and defæcation have all been observed on the first day of life. The newly born infant also possesses the reaction of sleep in its fully developed form.

Reflex activity to specific stimuli is shown by the presence of the corneal reflex and pupillary reaction to light. The patellar and Achilles tendon reflexes can also be obtained. Many other reflexes are present but they are often difficult to obtain. Ability to move the head or to lift it in order to free the nose for breathing is also characteristic of most infants in the very earliest period after birth.

Discrimination between the tastes of bitter, salt and sour substances, which produce movements of rejection, and the taste of sugar, which induces calm sucking movements, is said to be present during the first two weeks of extra-uterine life, but experiments are not yet quite conclusive on this point. Appreciation of temperature above and, especially, below body temperature is certainly established in the newborn infant though the exact thresholds are not yet known. Indeed, reaction to cold is more marked than reaction to painful stimuli. Definite response to auditory stimuli is not established until two or three weeks.

Certain postural movements and reflexes of movement found in the newly born are of psychological interest mainly because they tend to disappear in a few weeks in normal infants. Their undue persistence indicates retarded development. Among these responses are the Moro reflex, movements of arms and legs in response to rapid motion, and the tonic righting reflex described by Shaltenbrand. The grasp reflex, elicited when a stimulus touches the palm of the hand is present from birth and disappears when co-ordinated hand movements develop. Finally, the extensor plantar response, which, in infants, is accompanied by alternative associated reactions, such as withdrawal of the foot and motion of the leg on the opposite side, can be obtained on the first day and it changes gradually into the adult type of plantar response at the age of one year.

A dynamic approach to the investigation of the psychology of early infancy has been made by Marquis, who reported that experiments on changing the times of feeding showed that the process of conditioning could be detected in the first week or so after birth.

The Early Years. Since communication with the infant during the first year of life is very limited, most of the study of its intellectual development resolves into the objective study of its behaviour. Records of behaviour in standard situations have been standardized by Gesell for each month up till ten months, and after that for slightly longer intervals until thirty months. The techniques, by which these observations have been made, were often complicated and involved ingenious devices such as specially built alcoves, one-way vision screens and photographic tents. The infants were placed in special postures or close to specified objects and their reactions recorded and compared. There exists, however, a significant degree of variation between one infant and another as to the standard attained in behaviour, which has little relation to the ultimate intelligence level. Variations in rate of development independent of final achievement are particularly noticeable during the first year but become less important as the child grows older, for example, allowance for prematurity may be needed in the first few months, which can later be neglected. For this reason, early diagnosis of mental retardation should be guarded unless deviations from the normal level are found to be gross. Generally speaking, it is possible to identify idiots at birth or in the first month or two of life. Imbecility, however, unless accompanied by physical stigmata, as is mongolism, cannot always be diagnosed with certainty during the first year. Less marked degrees of mental retardation amounting only to feeble-mindedness, that is to say, the moron or simpleton level, cannot be ascertained until verbal development is available as a measure of mental functions. Even so, between the ages of two and three years intelligence measurements are much less reliable than during the school period.

Gesell divides the behaviour of the infant into four groups of activities, motor, linguistic, adaptive and social. Each of these types of activity shows marked changes and developments month by month. The division of the infant's mental processes into these categories is convenient for purposes of psychological measurement, but the instinctual and emotional development, which is the driving force behind the conditioning processes represented by these accomplishments, needs also to be emphasized. The instinctual aspect has been carefully studied by Bernfeld.

Motor Co-ordination. At the age of one month the infant should attempt to lift its head when held on the shoulder, at two months it can hold its head erect for a few moments, at four months, hold it steady when being carried. At one month, crawling movements are made when the child is laid prone on a flat surface, but at two months in this position it can also lift the chest slightly. At four months it attempts to sit up and stays sitting when supported. At six months it can sit momentarily without support. At this age, it can roll from dorsal to prone position and can grasp, and hold an object in either hand. At nine months it can sit without support and a little later can pull itself up into a standing position.

At one year, the infant can lower itself from standing to sitting position and can walk with help. Standing and walking without help are established at fifteen months and climbing stairs or getting into a chair are possible at eighteen months. At this age also, a pencil is used spontaneously for scribbling and a tower of three blocks can be constructed. Ability to walk backwards is achieved at twenty-one months.

At two years the child should be able to run and to build a pile of six blocks ; six months later it can go downstairs alone and pile up seven or eight blocks. Tests with form boards become practicable at this stage and thereafter standardized performances can be measured or timed.

Language. An infant aged one month gives heed to sounds and, in its cry, it is said to differentiate between expressions of pain and hunger. At two months, it attends to a speaking voice and may smile. Laughter is attained at four months and also elementary vocal response can be elicited. At six months, well marked vowels or syllables (' aroo ' or ' agoo '), are produced spontaneously and familiar voices are recognized. Sounds like ' da-da ' or ' pa-pa ' are used to express pleasure at nine months and, soon afterwards, rudimentary imitation of sounds can be observed.

The child of one year should be able to say about two ' words,' that is, sounds attached to real situations or objects, and it also reacts to very simple commands. Four words should be enunciated at fifteen months and about six words at eighteen months. At this period the child can learn to point on request to its eyes, nose or hair.

At two years, the child can name objects or pictures of objects and at two years six months has sufficient linguistic development to make the application of the Binet test possible.

Emotional and Instinctual Influences on Intellectual Development. Adaptive and social behaviour is dependent upon the development of reactions to internal instinctual drives. Early evidence of satisfaction or frustration of these inner forces is shown in emotional reactions. A fairly coherent interpretation of the development of the instincts in the infant has been made possible by the work of Freud. In the earliest stages, temporary emotional disturbance is expressed by muscular tension and it is believed that, from birth, states of anxiety occur commonly and are relieved when the environment is changed appropriately. Oxygen want may be the first stimulus producing anxiety and later hunger is the chief source. Anxiety is overcome initially by satisfaction of primitive desires, but later on the development of play gives a new outlet for emotional tension.

During the first few weeks the infant's existence centres round the mouth, which is by far the most sensitive part of the body and the source of all pleasure. When about two months old kinæsthetic sensations and tactile sensations all over the body begin to become important sources of pleasure for the infant ; this can be verified easily when the child is being fondled or bathed. As the awareness of the outside world develops, from the third to the sixth months, discrimination between different people and, in particular, specific reactions to the mother begin to appear, indicating emotional attachment. The driving force behind the process of social training is explained as mental assimilation or 'identification' with the mother at this period.

At about the sixth month, the infant begins to obtain pleasure from sensations connected with defæcation. This source of instinctual gratification becomes increasingly significant as the region of the mouth becomes less sensitive. The control of bowel and bladder, which is brought about normally at about the eighteenth month, corresponds to a period of rapid mental development and increasing play activity. The child obtains pleasure by copying the mother's wishes, *i.e.*, assimilating her point of view. The social control of the oral instincts is obtained to a considerable degree at twelve months, when the infant should be able to drink out of a cup.

The gradual change from dependence on primitive infantile sources of pleasure to pleasure in play and in intellectual activity was called 'sublimation' by Freud. Clearly, it is advantageous for the child to have sufficient intellectual apparatus to be able to carry out this change effectively. The intellectually backward children usually also show backwardness in their development of social habits and, in the majority of idiots and imbeciles, bowel and bladder training is only established very late, if at all.

The emotional level obtained by the child, however, is a poor index of its intelligence because, although the capacity to learn may be normal, disturbances of the instinctual life can interfere with the growth of the intellectual capacity. Cause and effect in this field are extremely difficult to disentangle. Failure to reach the normal standard on intelligence tests can be due to emotional disturbance, which may be recent or deep seated in origin. This has specially been found to be the case, when there is unexplained 'scatter' of scores, that is high scoring on one test or part of a test and unduly low scoring on another. Success on intelligence tests, however, does not necessarily exclude the possibility of the presence of emotional abnormality in the subject tested.

L. S. Penrose.

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CHAPTER X

EMOTIONAL AND INSTINCTIVE DEVELOPMENT

THERE are, so far, no standardized methods of determining the normality of a child's emotional and instinctive growth at any given age. Certain mental tests (Gesell) include an assessment of standards of behaviour at different stages of infancy, though this is done rather with the purpose of differentiating the intellectually normal from the mentally defective child than with the purpose of testing behaviour development itself. Certain tests (Rohrschach) inquire into the states of affective development and its disturbances. Other ' imagination ' tests utilize the phantasy productions of children to assess their emotional development, etc. But these attempts remain short cuts in investigations which do no more than furnish single data and throw light on circumscribed aspects of the child's emotional life. On our present level of incomplete and groping knowledge, they do not relieve the investigator of the obligation to study the whole complex personality whenever he wants to form a reliable judgment of this side of a child's nature.

The character-formation of the child and its consequent social response are based on the development and fate of two instincts : sex and aggression. Their manifestations and the emotions which arise from them have been the study of psycho-analytic psychology for the last fifty years.

Sex and Childhood

Until the beginning of this century childhood was believed to be free of sexuality. The sex instinct was supposed to begin functioning at the onset of puberty with the first stirrings of love for the opposite sex. This asexuality was taken as one of the main characteristics of childhood, which helped to strengthen the belief in the so-called ' happiness ' and ' carefreeness ' of the early years of life. Whenever manifestations of sexual interest (curiosity) or sexual activity (masturbation, sex play with other children) were found in a child, they were understood to be signs of grave abnormality, sexual precocity, or degeneration.

The Psycho-Analytical Theory of Sex

In contrast to these earlier beliefs, the psycho-analytic investigations, which were undertaken in connection with the study and treatment of the neurotic illnesses, demonstrated the existence of an infantile sexuality. This infantile sexuality is not identical with adult sex life so far as form and aim are concerned. Its component tendencies are the precursors of the adult genital strivings and provide for the child excitations and satisfactions similar in nature to the sensations of adult sexuality. The sex life of childhood naturally does not serve the purpose of reproduction, though it forms the basis and background for later genital functioning. The concept of sexuality which formerly included the genital function only, has thus become widened to include pregenital and extra-genital activities.

The energy behind the sexual drives of childhood and adulthood is designated by the term *libido*.

The Infantile Stages of Libido-Development

In childhood other parts of the body yield pleasurable sensations of the kind which in adult years are provided by the stimulation of the genital parts themselves. The first body zone to play this part in the child's life is the *oral zone*. From the beginning of suckling the infant experiences a pleasant stimulation of the mucous membranes of the mouth through the milk flow (see Chapter IV, The Establishment of Feeding Habits) and learns to reproduce this pleasure for itself, independent of the feeding process, through thumb-sucking. (Many infants suck instead of the thumb other fingers, or part of the fist, or other parts of the body surface within reach of the mouth, or a corner of the pillow or blanket.) In the later stages of infancy nearly all available objects are brought in contact with the mouth and, besides being tested and made familiar in this manner, provide pleasurable stimulation. The oral sensations of this kind form the child's first experience in pleasure of a sexual nature. They were looked at with suspicion and opposed by the environment long before their sexual nature had been disclosed. Attempts to break the habit of thumb-sucking met with a stubborn resistance on the part of the infant which proves the strength of the libidinal drive behind this activity. The oral zone retains the ability to yield pleasure through the sucking period, and with some children very much longer.

From approximately one and a half years onwards the *rôle* of the mouth for producing excitation of a sexual nature (erotogenic zone) is taken over by the bodily zone around the rectum, following probably on the abundant stimulation and attention centred on this region during the lengthy process of habit training. Simultaneously with the predominance of these sensations in the so-called *anal phase*, the child shows a marked interest in the whole process of elimination, a tendency to touch and smear with its own excrements and a preference for play with substances which resemble the excrements either in colour, consistency or smell. The child is as persistent in finding forms of ‘ dirty ’ play in the anal phase of its development as it has been in pursuing thumb-sucking in the oral phase.

Approximately between the age of three and four interest begins to be centred on the genital parts of the body. The organ which at this time yields the greatest amount of pleasurable stimuli is with boys the penis, with girls correspondingly the clitoris. In this *phallic phase* pride in the showing off of the penis and of the feats it can perform (erection, urinary play) plays a large *rôle* with the boy ; the envy of such performances with the girl (penis envy). Sex curiosity, *i.e.*, interest in the difference between the sexes, in the nature of intimacy between the parents and in the mystery of birth reaches its peak in this phase, which lasts roughly from the age of three or four to the age of five or six years. The central sexual activity of the phallic phase is, for both sexes, genital masturbation.

The claim that these tendencies of childhood should be recognized as components of the sex instinct is based on two facts : (1) that these pregenital activities are known to play a regular, though subsidiary *rôle* in adult sexuality either as an introduction or accompaniment to the act of genital intercourse ; (2) that in certain forms of sexual abnormality, the so-called perversions, any one of the infantile sex strivings can replace the desire for genital intercourse and become the main expression of the adult's sex life (fellatio, cunilingus, coprophilia, scoptophilia, exhibitionism, etc.).

Looked at from the point of view of adult genitality, the child's sex life is perverse (this may explain why observers were so reluctant to take notice of it) ; seen from a developmental point of view, the component instincts of infantile sexuality are normal.

The Development of the Aggressive Instinct

Many authors have expressed the opinion that the child's aggression is not an innate instinctive tendency but a reaction to the frustrations and prohibitions with which the child's wishes meet in the outside world. Recently the opinion is gaining weight that the aggressive instinct is a genuine and primary urge which operates in the child from the beginning of life.

The manifestations of the aggressive instinct are closely blended with the sex manifestations. In the oral phase they appear as *oral sadism* and find their expression in the wish to destroy the object of the child's liking by eating it (oral incorporation), the teeth being used as the weapon of aggression. In the anal phase, aggression plays an important *rôle* as anal sadism. Children of this age are normally aggressive, destructive, wilful, overmastering and possessive ; hitting, kicking, scratching and spitting are usual in their frequent states of anger and rage. In this phase it is especially difficult to separate the manifestations of sex and aggression from each other, since the child's whole attitude towards loved people or objects is normally inconsiderate, cruel, and tormenting. In the phallic phase aggression appears in the more pleasing attitudes of manliness, protectiveness, recklessness in face of danger, and competitiveness. Where the aggressive urges of children are not in the normal way fused with sexual drives they appear as a purely destructive force.

When directed towards the environment the aggressive forces serve the purpose of self-preservation, when directed inwards they threaten the child's own bodily or psychic health.

Auto-Erotism and Object Love

The child satisfies a small amount of its sexual and aggressive needs on its own body, in the form of thumb-sucking, anal pleasures, masturbation, and their derivatives (nail-biting, nose-picking, ear-pulling, etc.). The frequent states of rocking and head-knocking in early infancy belong to the same order, the former satisfying a primitive desire for rhythmic body movement, the latter giving expression to self-aggression.

These auto-erotic activities constitute the so-called ' bad habits ' of childhood against which the environment used to wage a ceaseless war. They are upheld by the full force of the instinctive tendencies for which they provide an outlet. The auto-erotic activities are in themselves normal and regular occurrences. By the environment they are felt to be opposed to the efforts of early upbringing since, so far as they provide gratification, they make the child self-sufficient and therefore less amenable to outside influences.

Normally, the overwhelmingly greater part of the sexual and aggressive desires is turned outwards and looks to the environment for satisfaction. The people of the child's environment to whom these strivings become attached, its *love objects*, are of the greatest importance for the normal balance of the child's whole emotional and instinctive life. Children who are treated with indifference by the people to whom they turn their feelings (' institutional ' children) or who change their environment repeatedly in their early years (evacuated, billeted children, boarded-out orphans, or otherwise homeless children), fail to form solid, lasting and satisfactory relationships. As a result, their sex strivings are turned back on themselves for satisfaction and their auto-erotic activities increase greatly at the expense of their relations with the outer world. The children then become indrawn, self-centred, and difficult to manage.

Excessive auto-erotic habits cannot be corrected or suppressed by the use of threats or punishments. They are influenced indirectly by the rise and fall in the child's object relationships. Where opportunities are created for the child to develop normal love relations with parents, or parent-substitutes, auto-erotism will automatically diminish in importance and take second place.

The Development of Object-Love

As described in Chapter IV, the infant forms its first attachment to the mother, or mother substitute who feeds it. This first ' love ' of the infant is selfish and material. Its life is governed by sensations of need and satisfaction, pleasure and discomfort. The mother, as an object, plays a part in this life so far as she brings satisfaction and removes discomfort. When the infant's needs are fulfilled, *i.e.*, when it feels warm, comfortable, with pleasant gastric sensations, it withdraws interest from the object world and falls asleep. When it is hungry, cold and wet, or disturbed by intestinal sensations, it turns for help to the outside world. In this period the need for an object is inseparably bound up with the great body needs.

From the fifth or sixth month onward the infant begins to pay attention to the mother also at times when it is not under the influence of bodily urges. It enjoys the mother's company, likes to be fondled and played with and dislikes to be left alone. It answers to the mother's presence and even to her moods in various ways. The wish for affection from her becomes a need, comparable in strength to the need for bodily care and comfort.

In the second year the relationship to the mother increases in force and intimacy. Many toddlers can hardly bear to be parted from their mothers, even for short periods ; they react to every separation with a violence and depth of feeling as great as if the mother had gone for ever. They are unable to play by themselves and cry helplessly or angrily whenever the mother leaves the room or the house. Falling asleep in the evening often becomes a difficulty for the same reason. Mothers are usually blamed for the behaviour of their toddlers, the distress about parting from her being taken as a sign that the mother has ‘ spoiled ’ the child. It is nearer to the truth that the mothers themselves feel helpless when faced with these passionate outbreaks, the reason for which they do not understand, and by force of which they are tied to the house and to the child. Enforced separations of long duration (evacuation, hospital, illness of the mother, confinement of the mother) often act as a traumatic shock to the child, and sometimes result in complete estrangement from the mother. Though the toddler torments the mother and treats her in an exacting and inconsiderate way (owing to the anal sadistic character of its wishes), the relationship between mother and child gradually becomes more of a give and take. Besides demanding satisfaction, the children begin to show love and affection on their part, to make small sacrifices for the mother, to share food with her, or to give her presents.

With the growth of intelligence and of awareness for the persons and events in the environment, the child ceases sooner or later to live in emotional partnership with the mother only and enters into the larger family group. Where elder brothers and sisters are present in the family, the child gradually adapts himself to the existence of rivals for the mother's love. On the basis of their common relationship to the parents it learns to share attention and material possessions with them and thereby makes the first important step towards development of a group spirit. Jealousy and envy of older brothers and sisters may be very strong. The feeling of being smaller and weaker may lead to a sense of helplessness and hopelessness in competition with them. But, on the whole, their older claims are recognized and the pleasure of being accepted by them and of being admitted to their companionship compensates the young child for having to give up the special care and attention from the mother which it has enjoyed during babyhood. The position is very different where younger brothers and sisters are concerned. The arrival of a next baby, which takes the toddler's place with the mother, is bitterly resented. The older child reacts by feeling betrayed, pushed out and deserted. It feels intense jealousy and hatred for the newcomer who has dispossessed it and wishes for his death or disappearance. It competes with the baby in every way, even to the extent of becoming wet and dirty again, of wanting to drink at the breast or from a bottle, or to sleep in a crib. Its love for the mother turns to violent anger when she opposes all these wishes. It is by now generally recognized that this emotional upset can become the cause of various disturbances, such as difficulties of sleeping and feeding, bed-wetting, incontinence of fæces, temper tantrums and other behaviour problems.

The relationship to the father is even more complex. Unlike the brothers and sisters, he is himself an important love object and, under normal family conditions, seems to the child to possess unlimited strength and power. He is therefore admired and feared by the child, as well as loved. But he is, at the same time, another rival for the mother's love and in this quality he is hated. This double relationship towards the father which is very marked already in the second and third year takes on further significance towards the fourth year when the child enters into the phallic phase.

So far the emotional development of boys and girls has proceeded similarly ; at this age they begin to develop along different lines. The boy identifies himself more and more with the father and imitates him in many ways. He changes at the same time in his behaviour towards the mother ; he ceases to be a dependent baby and turns into a young male, who acts protectingly and even condescendingly towards her, clamours for her admiration, performs all sorts of feats to impress her, and desires to possess her in place of the father. His sex curiosity is directed towards her intimate life with the father in which he wishes to replace him. The girl, on the other hand, has grown out of her complete attachment to the mother. She begins instead to imitate her, she plays mother herself with her dolls or with her younger brothers and sisters. She, in her turn, turns her love towards the father and wishes him to appreciate and accept her in her mother's place.

Both sexes in this manner have their first experience of being in love, with all the turmoil of feelings, hopes and wishes, disappointments and frustrations, joy and sorrow, anger, jealousy and despondency which this state involves. Their love for the parent of the opposite sex creates, or in the case of the boy intensifies the already existing rivalry with the parent of the same sex. The boy thus loves the mother, attaches his instinctive desires to her and wishes for the death of the father who stands in his way ; the girl loves the father and, in the service of the wish to have first place with him, phantasies doing away with the mother. It is this family constellation of the young child for which, in comparison with the Greek myth, the term *Œdipus complex* has been introduced.

(Though basically this pattern of the child's emotional life can always be traced, deviations from the norm are frequent. Many families are incomplete, and single or widowed mothers have to take over the father's *rôle* in addition to their own. Many fathers are weak and ineffective and badly suited to represent the male ideal for which the boy is searching. Owing to the bisexuality normally inherent in human nature, boys also display female, girls also male attitudes. Many boys, instead of moulding themselves on their fathers, identify with and imitate their mothers and develop a feminine attitude towards the father. The same so-called ' inverted ' œdipus complex occurs in girls and for both sexes leads to manifold abnormalities of psychological development.)

It is an error to believe that the children's feelings during these experiences are less intense than the corresponding emotions of an adult, or to belittle the significance of the child's emotional attitudes on the grounds that it is too young to take things seriously and too obviously unsuited to the *rôle* of sexual partnership in which it imagines itself. Every child at some time makes the inevitable discovery that the parents are not obtainable as objects of its desires, at least not to the extent to which it wishes to possess them. Many incidents occur which bring it home to the child that it is small, ineffective and inferior compared with the rival parent. Its wishes to be ' big,' to marry the loved person, and to produce children, which are the centre of the child's phantasy life at this period, fail miserably when applied to reality and meet with rebuffs and often with ridicule from the parents themselves.

When children finally recognize the futility of their œdipus wishes, their discouragement and distress are acute. In whatever manner they overcome the frustration of their first object love, the experience leaves its mark on them. It forms a pattern which will be repeated over and over again in later experiences, and which serves to explain the origin of the numerous, otherwise mysterious, idiosyncrasies, peculiarities and difficulties of adult love and sex life.

Instinct Transformation

The young child, under the influence of its instinctive wishes, is an uncivilized and primitive being. It is unclean and aggressive, selfish and inconsiderate, immodest and prying, insatiable and destructive. It has no powers of self-control and no experience of the outside world to guide its actions. Its only directive force is an urge to search for pleasure, and to avoid painful experiences. The task to shape out of this raw material the future members of a civilized society lies above all with the parents. In former years, public education authorities did not assume responsibility for children before the age of five, *i.e.*, at a time when the essential transformations of instinctive attitudes had already taken place. Since Nursery Schools have been officially recognized as the first stage in (public) education, this stage is now lowered to a period when the reign of infantile sexuality and of infantile aggression is still in full swing. This creates for teachers problems of handling and guiding the child which formerly existed only within the family circle.

In the environment the child's instinct life is subjected to an evaluation which is based on the normal and ethical standards of the adult community. From this point of view the oral attitudes of the infant are criticized as greediness, the anal wishes of the toddler as dirtiness, the aggressive and destructive urges as naughtiness, and exhibitionism as shamelessness. The degree of condemnation for the various phases of libidinal and aggressive development varies with the conventions of the class to which the parents belong. In some layers of society oral satisfactions are granted comparatively freely while anal attitudes and aggression are severely restricted (lower middle class) ; in others aggression and destructiveness are the main punishable crimes, while sexual curiosity is treated more leniently (upper middle class). To the young children of all classes, all moral standards of this kind are completely alien. The children themselves are only concerned with the tension which arises when instinctive urges remain unfulfilled. They experience this tension as painful and, to relieve or prevent it, attempt to satisfy each desire as soon as it makes itself felt. In their dealings with the instinctive urges, parents and children are therefore at cross purposes. The parents are concerned with the future adaptation of the child to adult standards, the child only with relieving the tension of the moment. The child strives for indiscriminate and immediate wish-fulfilment ; the parents are set on limiting, suppressing, or at least severely rationing gratification of the childish wishes. In this struggle which forms the nucleus of early upbringing, the child is normally the weaker partner. Since it is dependent on the parents for its material and emotional satisfactions, it cannot risk provoking their displeasure to any serious extent. Much as it fears the dissatisfaction which arises when instincts are thwarted, this fear is outweighed by two greater fears : to be punished by the parents or to lose their love. Owing to anxieties which lie latent in all children, the fear of punishment can assume fantastic forms. Where parents are merely moderately severe, the children may feel themselves threatened by cruel retributions of all kinds : to be sent away from home for having ' accidents ' ;

to have their thumbs cut off for sucking or their penis for playing with it (*castration fear*); to see their hands become paralysed for touching the genital parts, etc. It is usually overlooked that also the *fear of losing the affection* of the loved parents weighs heavily on the child's mind. Though this threat is commonly used by humane parents who wish to avoid severe measures such as corporal punishment, it is nevertheless felt by the child as an acute danger and acts as an effective deterrent against wish-fulfilment, equal and with some children more compelling than the fear of punishment. Whether the parents adopt one measure or the other, the average child will, in the long run, not be able to withstand them. It will, to a varying degree become obedient, *i.e.*, give in to their prohibitions and restrictions.

The outlook for wish-fulfilment in childhood would be poor under these conditions, if it were not for the pliability of the sexual and aggressive instincts which come to the child's help, and which is lacking in the case of the great body needs, as for instance, hunger and sleep.

A young child waiting for its food suffers from the rising tension of the pangs of hunger. It may be possible to distract its attention from these painful sensations temporarily by offering it satisfactions of some other kind (toys, play, singing, or other forms of amusement); after an interval the hunger pain will always re-assert itself. An oral satisfaction like thumb-sucking may again bring short relief; the same can be achieved by giving a drink of water or tea to produce the sensation that the stomach is filled. But all these substitute measures are limited in effectiveness and in the long run illusory. After each attempt at distraction the desire to eat will assert itself with greater violence until, finally, nothing can be done to alleviate the child's distress short of giving nourishment.

Fortunately for the purposes of upbringing, the component tendencies of infantile sexuality are not equally inexorable in their demands. They can be influenced by the child itself quantitatively as well as qualitatively when the need for it arises, *i.e.*, when it is either too difficult or too dangerous to live them out in the face of opposition from the environment. The toddler, for example, cannot keep up either his dirty or his cruel habits when they meet with the sharp disapproval of the mother. After finding by experience many times that she will either punish him or 'not love' him when he indulges in them, he alters his attitude to the tendencies themselves, begins to dislike them instead of liking them, withdraws from them more and more and finally 'forgets' that these were once his pleasures. The mental process behind this method of dealing with an instinctive tendency is called *repression.* It consists of not admitting into consciousness the images and ideas which represent that particular tendency in the mind. This excludes the tendency from consciousness, relegates it to the *unconscious* and creates the illusion that the wish itself has ceased to exist. It now operates from the unconscious but it ceases, at least for a time, to cause tension and suffering on the surface of the mind. Much of the sexual attitudes towards the parents, and the negative feelings against them which originate in the family constellation described above (Œdipus complex) are dealt with by this method of repression, which is of great importance for the child's psychological development. Repression is responsible for the division in the child's mind between consciousness and the unconscious; it is also responsible for the forgetting of the past and all that is unwanted in it, and for the later intolerance against all those wishes to which each individual has adhered in the first years of his life.

Where repression itself is not felt by the child to be a sufficient protection against a return of the forbidden and now dreaded urges, other mental methods come into use. In its development the child can over-emphasize in consciousness attitudes and qualities opposite to the rejected one. Formerly cruel children, for example, will develop excessive pity; children who have repressed their death wishes against members of the family, develop an attitude of special solicitude and anxiety concerning the health of their parents, brothers and sisters; whilst those who have repressed their exhibitionism become extremely shy. These over-emphasized attitudes and qualities are conscious *reaction-formations*, to guard against the return of the repressed instinctive tendencies.

There are other mental ways and means, which can be used either in addition to or in the place of repression, and which serve the same purpose. Toddlers, for instance, after going through a phase of aggressive biting will under the pressure of disapproval cease to act in this way, but then begin to complain that other children, or dogs and horses, or their toy animals are biting and attacking them and others. They even create in their imagination dangerous monsters, as in fairy tales, whose attacks they fear. What they have done is to *project* a forbidden impulse of their own into the environment. Where aggressive urges are not forbidden in themselves, but only in connection with the people against whom they are directed (for example, against the parents) they can be *displaced* to other persons, or to animals where they then have more chances to express themselves, etc

A special form of displaced wish-fulfilment is the so-called *sublimation* of primitive instinctive drives which is of special importance for the purposes of education. Many of the early pleasures of the child, as for example, playing and smearing with fæces, showing off its naked body, finding out sex secrets, can find outlets which are similar in nature to the original ones but acceptable to the environment instead of being forbidden by it. The child can, for instance, obtain much of the old pleasure in smearing when painting with colours and modelling with plasticine; it can enjoy showing off either its clothes or the various achievements of its body and mind in much the same way as it enjoyed crude exhibitionism; it can displace its curiosity from forbidden secrets to general knowledge and then obtain from learning much of the former pleasure. Where an instinctive urge is repressed, the energy or the libido contained in it are imprisoned with it in the unconscious and lost for use. Where the child succeeds in sublimating instinctive tendencies, the driving force behind the primitive urge becomes detached from its original aim and linked on to social attitudes and activities. These social attitudes and activities thereby become easy to achieve and very pleasurable instead of burdensome.

The time of life when these barriers against instinctive freedom are being erected, can hardly be expected to be 'carefree' or especially happy. The child feels harassed and driven much of the time, urged towards instinct gratification from the forces inside it, and urged towards repression and the giving up of instinctive pleasure from without. It vacillates in its behaviour, at times siding with the outer world against its own nature (being 'good'), at other times opposing the environment in the service of instinct gratification (being 'bad,' 'naughty'). This state of conflict explains the anxieties, the moods and the insecurity which occur inevitably in the early years of every child.

The greatest help in this difficult period is the emotional attachment to the parents. In the course of the first years the child has to give up much direct satisfaction and to put up with indirect and sublimated gratifications. It will find it easier to do so if the loss in pleasure is made up for it by the love, affection and appreciation given by the parents.

(A misunderstanding of these theories has led to the belief that the child can be spared these unhappinesses by unlimited licence being given to the infantile impulses. In fact, it is neither right, nor helpful to the child if this course is taken. The pregenital infantile sex impulses are merely preliminary stages of the sex instinct and, as such, are not meant to survive. Excessive satisfaction on either the oral, anal or phallic level attaches too much of the child's libido to that particular form of gratification and may therefore either arrest progressive further development or encourage regressions to these early stages, when difficulties arise in later life. Such fixations are seen to arise where children are sexually seduced early in life and thereby committed to some form of perverse (infantile) gratification. A child cannot safely indulge in unrestricted pregenital pleasures, just as it cannot fulfil in reality the phantasies of the Œdipus complex.

On the other hand, the difficulties of childhood can be lessened and much neurotic development prevented if parents learn to view the infantile impulses in a new light. It should be understood that these activities of the child are the outcome of biologically necessary, normal, and in themselves healthy attitudes. Each impulse, as it arises, should be treated on its own merits, according to its later *rôle* in adult life, instead of being judged from the point of view of conventions. The child should be given sufficient time to face its own impulses, to gratify them to some degree and then to outgrow and overcome them gradually. The child should, above all, not be driven into excessively repressive attitudes but instead be helped to find possible, permissible and enjoyable outlets for its instincts.

It is of no advantage to the child when steps in instinct transformation are taken too quickly. Habit training, for example, will have less harmful consequences for the child's psychological development (obstinacy, exaggerated disgust, obsessional attitudes) when it is performed in the course of two years instead of being completed earlier. Sexual curiosity should be permitted to survive until it can be directed into the channels of learning; aggression should be brought under control very gradually only, so as to leave sufficient energy available for sublimated active behaviour, etc. Average parents are proud if their children begin early to behave like adults who have their instincts well under control; for the healthy development of the child such a precocity of normal achievement is a potential danger.)

Emotions and Instincts in the Latency Period (School Age)

After reaching its climax approximately at the age of five, the child's relationship to the parents lessens in strength and infantile sexuality comes to a standstill. Instead of developing further until sexual maturity is reached (as happens in the animal world) the libidinal urges diminish and fade into the background. It is difficult to say how much of this change is due to the efforts at repression which have taken place in the former phase and have driven the expressions of instinct underground, and how much to a biological decrease in libido which occurs regularly at this age and lasts until pre-adolescence. Observations show that sexual activities between five and ten years are more obvious where early upbringing has failed for some reason and control of instinctive life has not been achieved in the first phase. On the other hand, some lessening of libidinal strength in the later period can always be seen ; this break in the course of sex development is an important characteristic of the human race. Whatever the reasons are, the sex instinct remains more or less latent in the second period of childhood. This leads to a comparative lack of emotional and instinctive content and consequently to certain significant changes in the child's behaviour, its anxieties, its object relationships and in the contents of its mind.

Behaviour in the Latency Period

The child emerges from the conflicts and struggles of its first five years with a definite split in its personality. It is no longer the purely instinctive being which it was at birth. Part of itself has changed in nature and has acquired new abilities and powers : to observe, interpret and record the happenings in the inner and outer world, and to control the responses which are made to them. This part has set itself up as a kind of central agency detached from the instincts from which it has developed, and (as described before), attempting to direct and control them. It is this side of its organization which the child now feels to be, and calls its ' self ' (*ego*).

Behaviour in the second period of childhood is as much determined by the reactions of the ego as behaviour in the first five years was determined by the instincts. The reduction in the strength of the sex wishes has relieved the child of some of its worst anxieties. Instead of having continually to look for satisfaction or to exercise control over dangerous wishes, its ego is left free to expand and develop and to use its intelligence and available energy in new directions. The child can now concentrate on tasks which are set before it even where they do not serve the purpose of direct wish-fulfilment but other interests. The *work* of school age can take the place of the *play* of the nursery child.

Play is one of the most significant activities for the young child, as important for its instincts, emotions and phantasies as it is for development of the senses and the intellect. As has been demonstrated by extensive psychological studies, the type and form of play which a child prefers at the various ages changes, not merely according to the state of its mental development, but according to the stage of the emotional problems for which play is an outlet. In the development of the child from toddler to school age the *rôle* of direct and immediate wish-fulfilment changes gradually to indirect and sublimated wish-fulfilment until finally the child is able to pursue and enjoy occupations which are not in themselves pleasurable but indirectly serve a pleasurable purpose. (Examples are the lengthy and strenuous preparations for building a hut, making costumes and scenery for play-acting, manufacturing figures for a puppet theatre, activities which progressive education uses as a transition from play to work.) The ability to enjoy play-work of this nature proves that the child's ego is now free to act without regard for the immediate fulfilment of instinctive urges.

Object-relationship and Identification

With the weakening of the passionate elements in the relationship to the parents, and with the growth of the child's intelligence and sense of reality, father and mother become less exalted and less frightening figures. The school child learns to compare its own parents with those of other children ; it forms new relationships with other people who are in authority over it, for example the teachers ; above all it realizes that the parents themselves are not as all-mighty as they had seemed to the little child, but themselves subjected and often helpless in the face of higher necessities and authorities. The need for approval and affection from them has become less vital, their disapproval and criticism less upsetting. The anxieties which had gathered around the two big fears of the young child (fear of punishment, fear of loss of love) are thereby lessened, though in this case a new form of anxiety is substituted for them. During the long period of complete dependence on the parents the child has followed their commands and prohibitions and imitated many of their attitudes until part of its own self has moulded itself on the pattern offered by the parents. This process of identification leads to the gradual building up of a new critical agency within the child which is above all concerned with moral and ethical attitudes, and exercises the function of the child's conscience (*super-ego*). While the emotional relationship to the parents is still at its height, this conscience is constantly reinforced by their educational influence from without. When this period has passed, the super-ego detaches itself from their actual persons, gains independence and rules the child from within, usually in very much the same manner in which formerly the parents have ruled the child. Where the child acts in accordance with the ideals laid down in the super-ego, it feels 'pleased with itself,' as it has felt when approved of and praised by the parents. Where the child disobeys the super-ego, it feels an inner criticism, or, as it is commonly called a *sense of guilt*. The child learns to fear that feeling of guilt as much as it has formerly feared criticism from the parents.

Where children reach school age without this process of identification with the parent figures having taken place in them, they can be considered as backward in their moral development. They lack guidance from within and are consequently on the level of infants where their social behaviour is concerned. Reasons for the failure of development of a super-ego are disturbances in the parent-child relationship, absence of suitable love objects in early childhood, instability of emotional attachments, etc.

Repression and Memory

Through the outward direction of attention and sublimated interest, the readiness to receive instruction, the new ability to collect information from book-reading and to concentrate on matters which are only indirectly of personal signifiance, the child of the latency period gains considerably in knowledge of the outside world. Some children of school age turn themselves into experts in special branches, as for instance geographical knowledge (through reading adventure stories or stamp collecting), mineralogy, botany, zoology (through collecting minerals, butterflies, botanical specimens, breeding pets), history, etc. Others become expert mechanics, chemists, physicists, electricians, intent on making their own, often dangerous, experiments.

On the other hand, this increase in objective knowledge is accompanied by a marked decrease in self knowledge. The repressions which have set in earlier in life are strengthened to a point where the child's self becomes more or less completely estranged from its instincts. The child cannot in reality live up to the ideal standards which it has set for itself. All it can do is to clear away from its consciousness the knowledge of the wishes, phantasies and thoughts which produce feelings of guilt. What the latency child actually knows of its own still remaining sexuality and of its aggression is negligible.

Since the whole past is filled with strivings and incidents which the child now criticizes as shameful and guilty, it also rejects the memories of the past from consciousness. This explains why the vivid and passionate experiences of the first years disappear from every child's remembrance and leave a blank. Few individuals remember more of their first childhood than a few isolated pictures which in themselves seem unimportant and devoid of emotional significance (*cover-memories*).

It is normal for the latency child to go through periods of varying length without any apparent sex activity, and to have sudden eruptions of phantasies accompanied by masturbatory activity when sufficient libidinal desire has collected. Where early education has been severe and repressive, such eruptions are followed by acute feelings of guilt, anxiety and depressed moods. Where these eruptions are entirely missing during the latency period, it is a sign that repression has done its work too well. In such cases it is difficult for the child to assume a normal attitude to sexuality in later life.

Some Aspects of Pre-Adolescence and Adolescence

The rigid equilibrium between the various parts of the personality which has established itself in the latency period does not survive the first stirrings of adolescence. The readjustments in the endocrine balance which occur at this age exert their influence on the emotional life of the child (especially the boy) in two stages. In the period of transition from childhood to adolescence no qualitative change takes place in the instinctive life, but the quantity of instinctive energy is increased; with the onset of physical sexual maturity, the beginning of adolescence proper, the change is of a qualitative character. The consequences for the psychological sphere are, in each period, different.

Pre-adolescence

The onset of pre-adolescence or puberty is marked by a general increase in instinctive energy which is not confined to any definite set of strivings but reinforces indiscriminately all instinctive forces. Libidinal and aggressive urges and attitudes, which were held under repression, thereby acquire new intensity, rise to the surface and break the barrier into consciousness. For parents and teachers it is extremely puzzling to see the changes which ensue. They are distressed at the idea that all their educational efforts have been in vain. The civilized manners, the control of temper, the conscientiousness about duties, which were to them a sign that the child was progressing well towards social adaptation, all disappear in quick succession. The pre-adolescent boy becomes greedy to the point of voraciousness, is unkempt and disorderly, unruly and impolite, conspicuous in his appearance and behaviour, often brutal to younger children and to animals. Masturbation and other auto-erotic habits are frequent; so are sexual activities with other children. Reaction-formations like disgust, shame, pity, which seemed to be firmly established in the structure of the personality, become ineffective. Many boys lose their interest in active occupations, become difficult in school, unsocial, moody and withdrawn. Where insight into their fears and phantasies can be gained, it is evident that their mind is busy, to the exclusion of other interests, with sexual imaginings, aggressive thoughts, death-wishes. There are, altogether, few new elements in this picture. What has come to the surface again is the familiar picture of infantile pregenital sexuality.

On the other hand, the re-awakened urges do not meet with the same treatment as before. The infant was undeveloped and weak where its ego-functions are concerned and, when left alone by the environment, eager on instinct-gratification and tolerant against the content of the wishes. The same functions have, in the intervening years, become rigid and consolidated, and compelling inner standards of behaviour have been set up. The toddler was able to enjoy its oral and anal activities ; the pubescent boy cannot pursue them without inner criticism. For the young child the sex attachment to father and mother was a first, moving love experience ; the growing boy is horrified about similar stirrings towards the parents. His masturbation is no longer a relieving outlet for sex tension as it was in early childhood ; self-masturbation, as well as masturbatory play with others is now laden with guilt and anxieties of the worst kind (the fear of going insane, etc.).

The pre-adolescent is, therefore, in a constant state of inner conflict. His mind has become a battleground where a strong, perverse and aggressive sexuality struggles against equally strong repressive forces. He simultaneously indulges in and rejects his instinct life. This double attitude accounts for most of the elements in his behaviour ; for his lapses from social adaptation, his unruliness, crudeness, his perverse and homosexual pursuits, but also for his moods, his unhappiness, his feelings of being an outcast, etc. Each of these manifestations corresponds to one or the other phase within the inner conflict.

Hostile behaviour towards the parents and the brothers and sisters of the opposite sex is explained by the necessity to ward off the sexual phantasies concerning them. Since their physical nearness accentuates the temptation and the ensuing struggle, family life at this period is extremely difficult to bear. The wish to isolate himself from the family, to enter group life, join group activities, etc., is therefore a healthy move of the young boy and should be encouraged by the environment.

Adolescence

The subject of adolescence is too complex and too far reaching to be treated within this section. No more will be attempted here than to enumerate certain aspects of it.

With the onset of physical maturity, a powerful wave of genital impulses makes itself felt and adds qualitative changes to the former quantitative ones. In consequence, libidinal interest is withdrawn from the pre-genital urges and attached to genital strivings. Genital wishes and the emotions, aims and objects which are connected with them take first place, while the pre-genital impulses and activities fade into the background. The immediate result is an improvement in the appearance of the adolescent boy, in whom the whole syndrome of boorishness, aggressiveness and perverse behaviour vanishes like a nightmare, to make room for the more adult masculine attitudes.

Normally, this biologically conditioned increase in genital sexuality is powerful enough to establish the normal adult sex organization which is characterized by the wish for genital intercourse taking precedence of all other urges, while the pre-genital (perverse) impulses are reduced to the *rôle* of unimportant subsidiary elements. In a large number of individuals, however, early sex development and sex education have failed in some respect. Where the child has experienced either too little or too much satisfaction (through over-strictness of education and excess of repression or through over-indulgence and seduction), strong fixations have been created to one or the other of the pre-genital wishes which now act as disturbing and distracting elements, prevent the achievement of genital potency, and become the cause for many of the abnormalities of adolescence.

Simultaneously with the re-organization of the sex impulses, another task of equally difficult order has to be accomplished in the emotional life. The adolescent has finally to detach his wishes from the objects of the past (mother, father ; sisters and brothers as their later substitutes) and to attach them to a new object outside the family circle. It is normal that this does not proceed smoothly. Many adolescents can only break the tie with the family with the help of violent upheavals, and reversals of feelings from love to hate ; this frequently includes revolt against the parents in all matters of daily life. Some adolescents are unable to escape from the original pattern of the family constellation and choose father and mother figures as their sexual partners. Some can only function emotionally and sexually where the new objects are in every way the reverse of the childhood ones (in personal appearance, social status, moral attitudes, etc.). Boys whose feminine attitude towards the father was marked in childhood develop passive homosexual attitudes in adolescence. Temporary homosexual object choice in adolescence, as a transition to heterosexuality is extremely frequent, etc.

The difficulties which arise before normal adult instinctive and emotional functioning is achieved are manifold. There seems little object in approaching their study, except on the basis of an understanding for the infantile development of which they are the outcome.

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CHAPTER XI

IMMUNITY

Under natural conditions, the resistance which an infant presents to an infective agent depends upon the interaction of a wide variety of factors. Many of these are quite unspecific, and operate indiscriminately for the protection of the host against many kinds of potentially pathogenic micro-organisms. Such structures as the ciliated epithelium of the respiratory tract, the acid-secreting cells of the gastric mucosa and the reticulo-endothelial cells of the digestive tract, are all in constant activity as non-specific defence mechanisms. Although, in the present chapter, we shall be concerned almost exclusively with those aspects of resistance to infection which are due to specific, largely serological, modifications associated with particular diseases, this should not obscure the fact that the active operation of such physiological defence mechanisms is constantly required for the preservation of health, and that any cause which may lessen their efficiency, may lead to the onset of disease. Neither should it be forgotten also, that such general defensive forces react to incipient infection with great promptitude, while the more specific responses only take place after the lapse of several days.

In immunology, we are concerned chiefly with the nature and mode of action of the specific factors in resistance to infection, and with trying to estimate in each special case the extent to which such agents as phagocytic cells and serum antibodies take part in the struggle between the animal host and its microbial parasite. During the past half century many of the immunological phenomena associated with the commoner infectious diseases have been carefully explored, with the result that it has become possible to distinguish various kinds of immunity, and to classify them in a more or less coherent scheme. The usual, and perhaps the most helpful, system of classification for the purpose of general exposition, is that based upon the sources from which any increase in specific resistance may be derived. This classification of the various types of immunity takes the following form.

(*a*) *Natural immunity*, in which resistance is augmented by factors which are inherited in the proper genetical sense of that term.

(*b*) *Congenital immunity*, in which resistance is increased by the presence in the tissues of protective substances obtained passively from the mother, either during intra-uterine life, or during lactation.

(*c*) *Acquired immunity*, in which resistance to further attacks of a specific infectious disease is raised as a result of a primary clinical or sub-clinical attack.

As will be apparent later, however, such a classification will need to be extended to include those forms of artificial immunization which have now become possible for prophylactic or therapeutic purposes.

At each age period in the life of a child, these differing forms of immunity contribute in varying degrees towards his protection from infection. At birth, he is dependent upon his natural immunity—the natural immunity of his species, race and family—supplemented by such congenital immunity as his mother may have transmitted to him. In succeeding months, while his natural immunity persists, his congenital immunity declines, to be replaced gradually, as he becomes successively exposed to the commoner pathogenic micro-organisms, by an acquired immunity which often lasts for the remainder of his life. The mode of operation of these forms of immunity, together with some general features in their application to particular diseases, will now be discussed rather more fully.

Natural Immunity

Our knowledge of the mechanisms underlying inherited immunity is still very rudimentary—much more so than our knowledge of those of congenital or acquired immunity. We know that each animal species is afflicted with its own characteristic infectious diseases, some of which may be peculiar to it, whilst others it may share with kindred species. But what the factors are, which have rendered particular host species vulnerable to particular parasites, is almost wholly unknown. Even amongst quite nearly related species, striking differences in susceptibility to the same infection may sometimes be found. Amongst the rodents, for example, the rat is almost completely refractory to diphtheria, and is little, if at all, affected by a dose of its toxin many hundred times greater than that needed to kill a guinea-pig of the same size. This is not the place to discuss possible reasons for such remarkable species differences, other than to point out that they are quite unconnected with any known antigen-antibody reaction, and seem rather to depend upon those fundamental biochemical differences that underlie species differentiation.

In addition to these wide variations in resistance between species, considerable differences may sometimes be found within the group of genetical variants that comprise a single species. The comparative immunity of Algerian sheep to the European form of anthrax, and the peculiar susceptibility of Plymouth Rock fowls to the Rous Sarcoma virus, are instances of this kind. For veterinary pathologists, such inheritable modifications are sometimes of considerable importance in the selection of resistant, or elimination of susceptible, variants of animals of economic importance.

Such differences in natural immunity as exist between different species undoubtedly find their parallel between the races and families in a single species, though the range of variation in resistance is naturally of a more restricted order. A critical review of much experimental work upon variations in inherited resistance to infectious diseases has been published by Hill (1934). In man, the preclusion of any experimental approach to the problem has much restricted any analysis of racial and other genetical differences in immunity. Even in such apparently striking instances of racial differences as the epidemics of measles and tuberculosis which followed the entry of Europeans into Polynesia, the environmental conditions of the natives were so different from those occurring amongst occidentals that the part played by genetical factors is impossible to disentangle. Nevertheless, although difficult to demonstrate, some differences in inherited susceptibility to particular infectious diseases almost certainly exist within the families of a particular race. For example, there are recorded instances of families in which no member has been known to contract measles in spite of repeated exposure, and similar familial resistance has also been observed in pertussis.

Sex also plays some part in determining the degree of natural immunity, though in most instances its effect is insignificant. Amongst young children, the best authenticated instance is the greater susceptibility of females to pertussis; in most of the other infectious diseases of childhood, where any sex difference exists, it is usually a greater susceptibility amongst males.

Congenital Immunity

Shortly after birth, the blood of young mammals can often be shown to contain specific antibodies for some of the commoner infections to which that particular species is liable. A number of investigations in both human and veterinary medicine have shown, moreover, that the degree of immunity of the offspring to particular diseases is often closely associated with the concentration of the corresponding antibody in its serum. Further, there can be little doubt that these antibodies have been obtained from the mother, for comparative studies have shown that their concentrations in the sera of mother and offspring are usually closely correlated.

The means whereby such protective antibodies pass from mother to offspring have been studied for a number of mammalian species. Two chief mechanisms have been found. In some species, amongst them man, antibodies pass across the placenta with comparative ease, so that the infant comes to possess its full complement of antibodies at the time of birth, and adds little if at all to them subsequently. In other species, amongst which the ruminants have been most fully studied, the placenta appears to be relatively, sometimes even absolutely, impermeable to the large protein antibody molecules, and congenital immunity is gained almost exclusively from the colostrum by absorption of secreted antibodies in an unchanged state through the mucosa of the alimentary tract. In lamb dysentery, for example, the serious consequences of depriving newly-born lambs of colostrum can be strikingly demonstrated by the greatly raised mortality from this disease which follows.

Amongst the commoner infectious diseases of man, diphtheria has been most fully studied from the aspect of congenital immunity. This has happened for two reasons: the serious character and frequent occurrence of the disease itself, and the relative ease with which accurate titrations of the specific antitoxin concentrations can be carried out in the sera of mothers and infants. Several careful studies, made in various parts of the world, have agreed in showing that the concentrations are almost invariably the same in both, and that the placenta is thus completely permeable to this antibody.

For other infectious diseases, the extent to which the mechanism underlying the congenital immunity has been investigated, has depended largely on the ease and accuracy with which the concentration of the antibody can be determined in the infant's serum. Provided sufficient serum is available, tetanus antitoxin can be assayed with considerable accuracy, and comparative studies upon the sera of women who had been immunized against this disease during pregnancy and of their infants immediately after birth, have shown that this antitoxin, too, passes readily through the placenta. Agglutinins and complement fixing antibodies for *H. pertussis* have also been found in the same concentrations in the sera of mothers and newly-born infants in a group in which the mothers have been actively immunized with this organism in the later stages of pregnancy. Agglutinin titres against organisms of the coli-typhoid group too, have been widely investigated; that some penetration takes place is evident, but the placenta does not seem to be so readily permeable to these antibodies as it is to the antitoxins of diphtheria and tetanus.

The technical difficulties attending the investigation of virus diseases have limited the extent of our knowledge of congenital immunity in many important infections. In a few instances, the direct estimation of the relative concentrations of virucidal substances has been carried out on the mother's and infant's sera. In most, our estimates have been mainly based on epideminological experience, and particularly upon comparisons of specific morbidity in the first and second six months of life. In poliomyelitis, infants at birth reflect the levels of immunity of their mothers, and comparative tests upon maternal and cord bloods have shown a close correspondence between the titres of the virus-neutralizing antibodies in both. Similarly, the sera of newly-born infants have been found to contain antibodies to the virus of human influenza. In measles, the evidence is indirect; amongst infants from birth to six months who had been exposed to the disease, only 10 per cent. contracted measles, while for those aged six to twelve months, the morbidity rose to 77 per cent.

In view of its importance, the persistence of congenital immunity after birth has been quite inadequately studied. That it steadily declines is known, though what factors affect this progressive disappearance are still largely undetermined. Many of the early estimates of the rate of fall were based on the average age of first appearance of a positive Schick test, but it is now realized that in the first few months of life the reading of this test is complicated by the peculiar non-reactivity of the skin to certain toxins (anergy), so that negative reactions are found with fallacious frequency. While part of the decline in immunity takes place inevitably in consequence of the progressive dilution of the passively-acquired quotum of antibodies in the steadily increasing volume of tissue fluid in the body of the growing child, the main loss probably results from the continuous katabolism of the serum proteins. From animal experiments, it has been shown that the destruction of injected homologous serum proteins takes place rapidly in inanition, and it may well be that, should an infant lack an adequate supply of new amino-acids in its diet, he may be compelled to break down prematurely the antibody proteins he had received from his mother. Recent experiments upon the persistence of injected homologous serum proteins that have been marked with a distinguishable isotope of nitrogen, indicate that under ordinary conditions of nutrition they are still recoverable after several months. It appears likely, therefore, that under normal circumstances, a significant level of immunity can be expected to last for several months after birth; at the end of this period, however, unless it is fortified in some active manner, the infant's immunity will fall to a level which is quite insufficient to afford protection.

Naturally Acquired Immunity

Under ordinary circumstances, once the peculiarly vulnerable period of early infancy has been passed, and congenital immunity has waned to a negligible level, the infant becomes liable to contract a wide variety of infectious diseases. Some of these diseases are so prevalent, especially in urban communities, that few persons pass through life without suffering from an attack in either a clinical or a sub-clinical form. From such attacks, the child develops an immunity which often lasts for a lifetime. The raised resistance gained in this way is known as the active form of acquired immunity, and depends upon the more or less permanent sensitization of the cells of the reticulo-endothelial system to the specific antigens of the micro-organism concerned. From this it follows that, were the tissues again invaded by the parasite, the formation of the specific antibodies would take place promptly and effectively. Indeed, so rapidly are these antibodies formed under the influence of a second stimulus, that the critical serum level needed for effective protection may be exceeded well within the usual incubation period for the disease.

Just as the persistence of congenital immunity is probably shortened by defective nutrition, so the development of actively acquired immunity is also impaired by inadequacy in the protein components of the diet. Hartley (1943) and Cannon (1942) have both recorded diminished antibody responses to active immunization in animals on deficient diets. and Whipple (1942) found that dogs, made anæmic and hypoproteinæmic through partial starvation, were unduly susceptible to infections. The influence of diet upon the development of actively acquired immunity is clearly important, particularly during the present period of widespread food shortages in many European countries, and deserves a more complete examination than it has yet received.

Prophylactic Immunization

Until comparatively recent years, all actively acquired immunity was obtained at the price of actual infection, with all its inherent dangers. Within the last two generations, however, the science of immunology has made such progress in the control of the commoner infectious diseases, that, by the use of certain prophylactic measures, such risks to the lives and health of children need now seldom be run. Some of these prophylactic measures are of such great practical importance, that they require separate consideration; they are well discussed by Parish (1947).

Small Pox. The replacement of the formerly widely used variolation by the much safer vaccination about the beginning of the nineteenth century, marked the opening of a new era in the control of infectious diseases. Not only was the conquest of small pox itself an immense achievement, but the stimulus it provided later in the century for Pasteur and his colleagues, was a major incentive in their early investigations in immunology.

The success of the simple and safe prophylactic procedure of vaccination is now accepted so widely, and based on such unimpeachable evidence, that it requires no further comment here. An admirable review of its development as a branch of preventive medicine has been written by M'Vail (1906). In recent years, discussion upon vaccination has centred less on its value in the prevention of small pox, than upon the risk of certain serious complications that occasionally attend the procedure itself, and upon the balancing of these risks against those of contracting the disease. Amongst these risks, post-vaccinal encephalitis has assumed considerable prominence in recent years. Fortunately, however, this complication is very rare both after the primary inoculation of very young children, and after the secondary inoculation of older ones. Consequently, were all children to be vaccinated well before their first birthday, and again when between five and seven years of age, the frequency of post-vaccinal encephalitis would be negligible. That serious post-vaccinal complications are rare, particularly in infants, was ascertained by the Committee on Vaccination, which issued its Report in 1928. During the period 1911 to 1925, more than five and a half million infants were vaccinated, and only forty-six died as a result of effects which were directly attributable to it. In the last few years, even these small risks have been much lessened, for the dangers of sepsis, from the effects of which most of the above infants died, have been greatly minimized both by the use of more careful methods of vaccination, and by the introduction of modern chemotherapy.

Although an attack of smallpox itself almost invariably confers a life-long immunity, a successful inoculation with vaccinia virus in infancy often fails to remain protective after adolescence. Dependence upon a single inoculation was the only serious error in the system of vaccination recommended by Jenner himself. Early in the nineteenth century, this mistake was recognized, and to-day the principle of three successive vaccinations at roughly seven-year intervals has become generally accepted. Often the second and third attempts fail to take, or take only in a modified form; the first of these signifies that a high level of immunity has persisted, the second, that a lower level has been fortified. The significance of these responses has recently been discussed by Leake (1936).

The method of vaccination recommended by the Committee of Vaccination was to place four droplets of lymph upon an area of skin previously cleaned with alcohol, and to make single superficial scarifications about a centimetre long through each. A simple dressing of boric lint or sterile gauze should be applied, and renewed a week later when the progress of the lesion should be observed.

In recent years two important modifications of the scarification method have been introduced. In the first, diluted lymph is injected intradermally through a fine needle. Apart from the saving of lymph that results in large scale vaccination schemes, this method has the advantage of lessening the risk of infection at the site of inoculation, and the subsequent formation of a pustule and scar. For such injections, however, specially prepared virus suspensions are needed. In the second modification, the entry of the virus is procured by multiple applications of light pressure to the skin beneath the droplet of lymph. This procedure has been described in detail by Parish (1944).

Diphtheria. That an immense reduction in the incidence of diphtheria follows the general immunization of infants and young children, has been conclusively shown by experience in Canada and in the United States, and latterly in this country also. The whole question has recently been admirably reviewed by Russell (1943). Not only does the morbidity from this disease in the child population fall rapidly after widespread prophylactic immunization, but the case-fatality rate too is much lessened. In an answer given recently in the House of Commons, the Minister of Health stated that in the first six months of 1945, there had been 6,168 notified cases of diphtheria with 289 deaths. Of these, 4,209 cases with 265 deaths had occurred amongst non-immunized individuals, while 1,959 cases with 24 deaths had taken place amongst the immunized: the case-fatality rate amongst the immunized was thus less than one-fifth of the non-immunized. The final position, when both the morbidity and mortality statistics have been amalgamated, has been succinctly described in a report of a survey carried out by the Ministry of Health as follows : ‘ In the two years (1942 and 1943) combined, the estimated rate of dying from diphtheria was about 23 times as great amongst the non-immunized as amongst the immunized.’

At the present time, two immunizing agents are in common use : alum-precipitated toxoid (APT) and toxoid-antitoxin floccules (TAF). Both are highly potent antitoxin producers, and both can be used in infants and young children in doses sufficient to procure immunity without fear of serious reactions. Much work has been done to determine the best procedure for their administration. In general, two points require particular attention : (*a*) the initial dose should be as large as is consistent with the absence of any undesirable reaction ; and (*b*) the second dose should not be given until several weeks have elapsed after the first. The advantage of delaying the second injection was clearly shown by Barr and Glenny (1945) who found that in large groups of animals, the serum antitoxin titres rose on average to 0·066, 0·56 and 1·17 units per cc. when the second injections were given after intervals of one, two and three months respectively.

In a small proportion of children which are injected prophylactically with diphtheria toxin, the resulting antitoxin response is too small to ensure their immunity. Such individuals can be identified by the routine Schick testing of all inoculated children several weeks after the last injection, and should be submitted to a further course of inoculations. In large-scale prophylactic schemes, however, the Schick testing of all inoculated children is seldom practicable ; under these circumstances, trial samples of the inoculated population should be tested from time to time to ensure that the methods and materials used continue to be satisfactory.

The Schick test depends upon the concentration of antitoxin in the circulating and tissue fluids of the subject. When this is low, the toxin injected remains largely unneutralized, and, by its noxious action on the skin cells, brings about a local erythema ; when it is injected into an immune person, the toxin is fully neutralized and no local reaction takes place. The quantity of toxin introduced in this test has been nicely balanced, so that a positive or negative reaction provides a good indication of clinical susceptibility or immunity to diphtheria. The balance, however, has been based upon statistical experience with large numbers of children, and exceptions to this rule of agreement occur not infrequently. An admirable account of the theory and practice of the Schick test has been given by Dudley (1929).

When children have been exposed to diphtheria, it is too late to rely upon any active prophylactic measures—the incubation period of the disease is much shorter than that needed for the production of antitoxin. Under these circumstances passive protection should be conferred by the injection of antitoxin, preferably in the form of separated, partly digested, globulins. Such refined antibodies have the great advantage over those in unprocessed horse antitoxic serum that the risk of anaphylaxis, or serum reactions such as urticaria, arthritis, albuminuria, are almost completely obviated. Given in doses of 25 units per pound of body weight, such antitoxins remain in the tissue fluids at an immunizing level for several weeks.

In recent years a means of controlling diphtheria outbreaks, particularly in schools and children's institutions, has been devised which combines the advantages of both active and passive immunization. By the simultaneous injection of antitoxin and toxoid, immediate protection is ensured against the imminent risk without delaying the initiation of active immunity. The procedure entails the injection of 350–500 units of *refined antitoxin* into one arm together with 0·1 c.c. A.P.T. into the other; one month later a second dose of toxoid only (0·3 c.c.) is injected in order to complete immunization. The paper by Fulton, Wells, Taylor and Wilson (1941) should be consulted by anyone wishing to take advantage of this valuable advance in prophylaxis.

Whooping Cough. In consequence of the high mortality of young children from pertussis, much work has been directed to the development of effective methods of specific prophylaxis. Much of the difficulty has arisen from the immunological instability of the responsible organism, *H. pertussis*, under conditions of cultivation.

When full precautions have been taken, however, it has been claimed that vaccines can be prepared which are capable of evoking an actively acquired immunity in infants sufficiently persistent to minimize their risk of serious infection during the specially vulnerable first two years of life. In the United States, such vaccines have been used freely, and the satisfactory results which have followed have been recorded in the 'Round Table Discussion on Whooping Cough' (1942). In this country they have been less used, and on the whole reports have been less favourable. McFarlen, Topley and Fisher (1945) record their findings for children in city and residential nursery groups. Of the city children, 327 had been vaccinated with a pertussis vaccine, and 305 of similar ages were kept as controls; of the former 41, and of the latter 43, contracted definite pertussis. The vaccination thus appears to have afforded little or no protection, nor did it lead to any substantial modification in the course or severity of the attack. It seems clear that more extensive studies are needed before any generally applicable scheme of widespread vaccination for pertussis can be recommended.

Tuberculosis. Of the various forms of evidence which have converged to attest the prevalence of tuberculosis amongst Europeans, none has been more widely used than the Tuberculin Test. This test, which has undergone many modifications since its introduction by von Pirquet, is now commonly used in one of two forms : the intradermal injection method of Mantoux, and the percutaneous method, in which the specific substance is dissolved in a suitable base and applied to a protected area of thin skin such as the forearm. This latter method, although still not always as sensitive as the intradermal one, obviates the risk of infection which accompanies injections, and is tending to replace the Mantoux test for ordinary routine work. The tuberculin test has been further improved in recent years by the introduction of refined specific substances from the tubercle bacillus, (P.P.D., or Purified Protein Derivative) which can be kept in a dry stable form until immediately before use. The former solutions of Old Tuberculin which, especially in the higher dilutions, tended to deteriorate rapidly, are now obsolescent.

Tuberculin surveys have not only drawn attention to the general prevalence of tuberculosis (see Hart, 1932), but they have also shown in a very clear way that the children in a family in which an open case of the disease is living, run a much enhanced risk of contracting the disease. It was largely to combat such dangers that Calmette and Guerin originally introduced their method of conferring active immunity by the introduction, either by mouth or by injection, of a small dose of living, but almost avirulent, tubercle bacilli. The severely critical handling to which Calmette's early papers were subjected by Greenwood, however, so discouraged investigations into the value of prophylactic inoculation with B.C.G., that scarcely any studies on these lines have been undertaken in this country. Abroad, the method has been widely used both for the protection of children and adults. On the whole the reports have been cautiously favourable, but, as in most cases in which results, though apparently significant, are not dramatic, difficulties have arisen in ensuring sufficient suitable control subjects. One large-scale experiment, carried out with great care, has been described by Aronson and Palmer (1946), in which prophylactic inoculation with B.C.G., was undertaken in several tribes of North American Indians. In five tribes, 1,550 children and adolescents were inoculated with B.C.G., while

1,457 similar individuals were observed as controls. Yearly X-ray examinations were made for six years upon nearly all the members of both groups. At the last of these examinations, 12·7 per cent. of the controls showed tuberculous lesions, and only 2·6 per cent. of the inoculated group. The figures for moderate to advanced cases were 3·3 per cent. and 0·6 per cent. respectively. During the same period, 28 of the control, but only 4 of the vaccinated, persons died from tuberculosis. A similar study was made by Rosenthal, Leslie and Loewinsohn (1948) on infants in a poor district of Chicago. Again, the vaccinated were found to have significantly lower morbidities and mortalities than the unvaccinated. From these and other studies (see Wallgren, 1948), it would seem desirable that a systematic study of this method of prophylaxis should be undertaken in this country in the near future. For the present, however, the method as a prophylactic measure should still be regarded as being in the experimental stage of development, and unsuitable for general application.

Measles. Although hitherto no practicable method for active immunization against measles has been developed, a great advance was made when it was found that an attack of this disease in a susceptible exposed child could almost invariably be controlled by an injection of convalescent serum at some time within the incubation period. The severity of the resulting attack was chiefly determined by the interval which elapsed between the exposure and the injection: given early, the attack could be aborted, given later, it could be proportionately mitigated. Which effect is to be preferred, depends upon the particular patient concerned. If he is a very young, or feeble, infant, or a child suffering from some other disease, it will almost always be desirable to avert the attack of measles completely. If the child is older and healthy, a mitigated attack is preferable, for this has the advantage of conferring a substantial immunity to further attacks of measles at the cost of a trivial indisposition.

Hitherto, the most widely used source of virus-neutralizing antibody has been the serum from convalescent cases of measles. Generally, the serum in doses of 5 c.c. for infants under three years, and in doses of 2 c.c. per year of age over three years, is given in unmodified form. Recently, however, separated antibodies, often referred to as ‘ gamma globulins,’ have been employed more widely, and with the ever-present risk of the spread of infectious hepatitis by crude human serum, its use is to be encouraged. Placental .extracts have also been prepared having considerable immunizing power. The whole question has been well reviewed by van Rooyan and Rhodes (1940).

Tetanus. Although deaths from tetanus are not nearly so common as from the above four infectious diseases (about forty to fifty children in England and Wales die yearly from tetanus), the ease with which this terrible disease can be prevented by a simple prophylactic inoculation makes it worthy of consideration in any broadly planned immunization scheme.

Multiple Immunization. The field of practical prophylaxis by active immunization has now become so widened that there is serious risk that it may not be used to full advantage because of the administrative difficulties involved in carrying out so many specific inoculations. This danger has been fully appreciated by those closely concerned with the problem, and much work has been done in an endeavour to combine several specific antigens in a single injection mixture. So far, combinations of diphtheria toxoid, tetanus toxoid and typhoid-paratyphoid vaccine have been used in adults, and mixtures of the same two toxoids with vaccines of *H. pertussis* in infants. Under such conditions, all the antigens used are active immunologically, and the resulting reaction in the subject is not unduly severe. Within the next few years, the use of such multiple antigens will probably become commonplace.

Before leaving the question of active prophylactic immunization, it should be pointed out that applied immunology is undergoing rapid evolution at the present time, and that no one responsible for the care of infants and young children should fail to keep themselves informed about the developments that are being made. Although the fundamental principles of immunology are not likely to undergo serious modification in the future, the practical procedures for their application to prophylaxis will unquestionably be steadily improved.

The 'Inevitable Infections': Diphtheria, Measles, Pertussis, Tuberculosis, Mumps, Rubella and Varicella

Certain infectious diseases are so prevalent in this country, that in spite of all reasonable precautions, practically every child contracts most or all of them before reaching adult life, and their occurrence is generally accepted as one of the inevitable misfortunes of childhood. With most of these diseases, the infection usually manifests itself as a clinical attack, with sufficient diagnostic features to render its recognition comparatively simple. With others, notably with diphtheria and tuberculosis, subclinical cases are far commoner than overt attacks, and it is only within recent years that the real, and high, incidence of these diseases have been fully appreciated. The evidence which has been chiefly responsible for this change of view has been gained mainly from large-scale Schick Test and Tuberculin Test surveys. It has been by combining returns for notified cases (where available) with estimates obtained in these indirect ways, that it has been possible to arrive at a more correct idea of the true incidence of some of these diseases in the child population. Such cumulative morbidity curves for diphtheria, measles, pertussis and tuberculosis in childhood are shown in fig. 43.

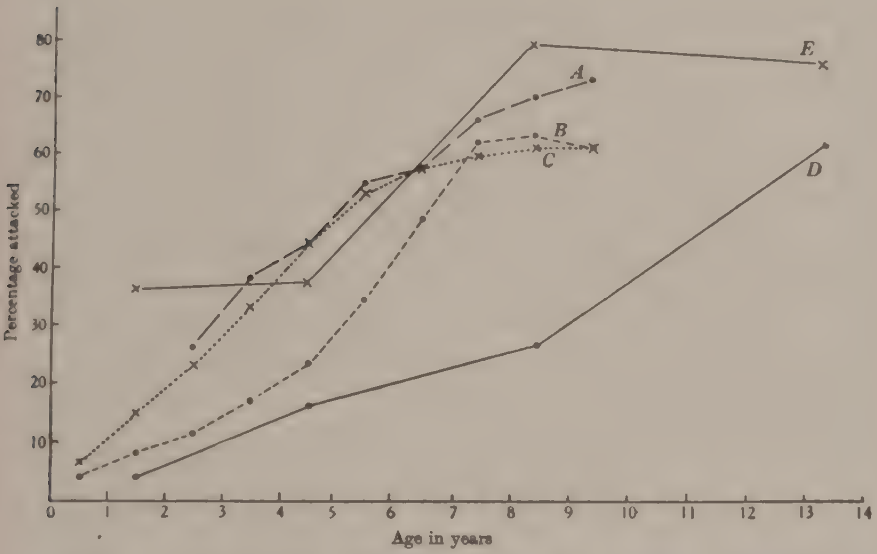

Fig. 43. Cumulative morbidity curves for diphtheria, measles, tuberculosis and pertussis for children in the London area. A, Schick-negative reactors in L.C.C. children (1932–36). B, average percentage of children 'not at risk' to measles in St. Pancras (1924–27). C, percentage of children 'not at risk' to pertussis in Battersea (1925–29). D, tuberculin-positive reactors in families with no open case of tuberculosis (1930). E, tuberculin-positive reactors in families with an open case of tuberculosis (1930). (Wright, G. P., and Wright, H. P., 1942. *J. Hygiene*, **42**, 451.)

From the epidemiological point of view, the comparative importance of the infectious diseases can best be judged by their death rates. Below are given the proportionate death rates, set out by percentages to facilitate comparison, for the above seven diseases amongst children under fifteen years in England and Wales for the decennium 1931–40.

Tuberculosis	32·9
Measles	26·6
Pertussis	20·5
Diphtheria	19·4
Varicella	0·4
Rubella	0·1
Mumps	0·1

From these figures, it can be seen that these seven 'inevitable infections' fall sharply into two groups—the serious and the relatively benign. The epidemiology of the first four diseases as they occur in young London children, together with their relationship to social conditions, has been examined recently by Wright and Wright (1942).

In all the major infectious diseases of childhood, no single factor so greatly influences the likelihood of recovery or death as the age at which the infection has been contracted. This well-recognized effect of age is clearly shown by the gradient of case fatality rates found in recent years for London children, some of these rates are set out in the following table.

TABLE 14

CASE FATALITY RATES (PER CENT.)

	Age Group				
	0–1	1–2	2–3	3–4	4–5
Measles	6·2	5·8	2·1	0·5	0·4
Pertussis	7·4	1·7	0·3	0·4	0·1
Diphtheria	9·4	7·8	—	4·6	—

No comparable data are available for tuberculosis, but from the figures given in various published series, it seems highly probable that a similar age-gradient occurs with this disease also.

In consequence of the much greater risk that very young children incur from these infections, it becomes an object of the first importance in child care to mitigate both their incidence and severity at these early ages. The greater average age at which children of the better-to-do classes contract measles and pertussis, is itself largely responsible for the close correlation between the mortalities from these diseases and the economic circumstances of the parents. While the gradual rise in the standard of living in this country has undoubtedly contributed greatly to the progressive decline in the death rates from these diseases, it is important to bear in mind that the beneficial operation of non-specific social improvements can now be supplemented by potent specific measures directed to lessening the severity of attacks in very young children, or in those whose general resistance has been impaired by some concurrent disease. By the inoculation of exposed infants with serum from convalescent cases of measles, or with serum from horses specially immunized with *H. pertussis*, the gravity of the subsequent clinical manifestations can often be modified. Even under these circumstances, however, it is generally preferable that the attack be not aborted completely, but rather that it be allowed to develop in an attenuated form, so that it leaves behind it a residual active immunity. In recent years considerable progress has been made in the separation of particular antibody fractions from the remaining inactive serum proteins. In measles prophylaxis, this extractive is often known as the gamma-globulin fraction, but since antibodies in general are now known to be associated with this serum component, the use of the term for specific measles antibody should now be discontinued.

Control of Infections in Infant Communities

In the many forms of publicly and privately organized nurseries, crêches, residential nurseries and schools, as well as in the wards of infants' hospitals, the opportunities for the spread of infection are unusually favourable. In ordinary families, the infant comes chiefly into contact with adults and older children, but in institutions the age distribution is highly abnormal and the chances for contact between susceptible infants are correspondingly increased.

In institutions caring for very young infants, the principal scourges are impetigo and a peculiarly lethal form of enteritis, now generally known as neonatal diarrhœa. Little is known with certainty about the etiological factors in either disease, and reliance must chiefly be placed upon a high standard of hygiene, the early recognition of clinical cases and the complete isolation with barrier nursing precautions of all infective infants. The details involved in carrying out such precautionary measures will be found set out fully in the M.R.C. War Memorandum No. 11 (1944) dealing with Cross Infection.

In institutions for older children, infectious diseases are usually introduced by new arrivals or at the time of visits by young friends and relatives. The latter can be largely obviated by prohibiting the admittance of child visitors, however ostensibly healthy they may seem; the former can only be prevented by effective quarantine regulations. In addition, all infants both in institutions and in private families, should be vaccinated a few months after birth and actively immunized against diphtheria shortly before their first birthday.

Conclusion. The steady fall in infant mortality which has taken place in the present century, has chiefly resulted from the interaction of two great groups of factors. In the first are the many agents of a general social nature—housing conditions, nutrition, education of parents, etc.—which accompany a rising standard of living. The part to be contributed by such factors in the future will, as in the past, be mainly governed by economic developments of a national and international character over which the medical profession can, at present, only exercise a limited measure of control. The second group of factors, however, are specific in character, for they depend upon advances in the principles and practice of medicine itself. It is in this aspect of social betterment that medical administrators and practitioners can play a dominant part if they make full use of all the help that is open to them. The vast body of knowledge upon contagion, the microbial parasites of man and animals, and the protective immunological reactions which often follow infection, stands as a tribute to the co-operative labours of a host of investigators in many countries. The seed sown by these pioneers is gradually coming to fruition, and in no branch of medicine is the harvest richer than in the prevention and treatment of the infectious diseases of children.

G. Payling Wright.

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PART II

SOCIAL ASPECTS OF CHILD HEALTH

CHAPTER XII

GENETIC FACTORS AND POPULATION

I. VARIATION

Causes of Variation. The idea that heredity and environment are mutually exclusive causes of variation dies hard. Admittedly there are certain characters that it is impossible to modify by environmental changes compatible with life; eye colour and certain serological characters are examples of these. Most types of variation are subject to both influences; for example, height is certainly subject to genetical control, but it is no less certain that environmental factors also play a part. It is obviously easier for a geneticist to work with characters not easily modifiable, and this has perhaps tended to perpetuate erroneous ideas.

Types of Variation

Continuous Variation. The word ' normal ' as used in ordinary speech usually coincides with healthy. Scientifically, it is often virtually impossible to say where a condition becomes pathological.

Suppose we were to make red cell counts on 5,000 people in London. We should probably find a few with about 1 million cells per c.mm., and a few with 10 or 12 million. The average would be between 4 and 5 million. People at both extremes would certainly be ill, but there would be no definite point below 4 million where we could say with certainty that anæmia began. This type of variation is called continuous variation and any division into normal and abnormal must certainly be arbitrary. Such definition must often be made for legal purposes, as for example in the differentiation of varying degrees of mental defect.

Our knowledge of the genetics of characters showing continuous variation is necessarily meagre. Animal experiments in which the environment can be controlled shows that the number of genes[1] concerned with the development of such characters is large and with few exceptions we cannot say what each individual factor does. With characters such as height or intelligence in man, we may be confident that a large number of genes are concerned, but we cannot control the environment, and nobody can tell how many simpletons might have been normal if their prenatal and neonatal conditions had been improved. All we can say at present is, that if we take a large group of parents and measure their height or intelligence, the average values found in the children when these become adult will be the same as those found in the parents. This type of relationship is expressed by a mathematical device known as the correlation coefficient.

With regard to hair and eye colour, the situation is somewhat similar. Here again the average values correspond in parents and offspring. This may sound a surprising statement, and part of the difficulty is due to the fact that the characters have not been properly defined. For example, where shall we draw the line between a light brunette and a dark blonde and what precisely is the difference between various types of red hair? In order to get accurate genetical results, these definitions must be so established that a worker in Aberdeen may be quite sure he is studying the same character as another in London or New York. Ultimately we shall probably know the effects of all the common genes influencing these characters, as we do in the case of certain rodents.

The difference between straight and wavy hair is determined by the shape of the cross section of the hair. In negroes it is markedly oval even within the hair follicle. In Europeans with very frizzy hair, the follicle is not markedly oval but the hair is. It is claimed that this character is inherited as a simple recessive. In people with wavy hair, there is a less strong oval, whilst with perfectly straight hair the section is circular.

Discontinuous Variation. Although we can draw a continuous series in hair colour from jet black to ash blonde there are certain people who have small areas of perfectly white hair. Here the variation may be said to be discontinuous, there being nothing arbitrary in distinguishing a man with a white forelock from the rest of the population. Genetically, the behaviour varies in different families. In some, it affects both sexes and behaves as an ordinary dominant gene, *i.e.*, there is always one affected parent. In others it is limited to male members of the family, though both males and females may transmit it. Occasionally it does not seem to be inherited at all.

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[1] Genes are the units of inheritance and are carried on the chromosomes. They may be single molecules. We can only recognize the action of a gene if it occurs in more than one form. Thus the gene ' t ' causes taste deficiency, and we therefore deduce that ' T ' determines ability to taste. It is perhaps more logical to talk about gene substitutions or gene differences than genes. We can only tell whether *character* differences are due to single gene differences by seeing whether they follow Mendelian laws. Capital letters are used to denote dominants and small letters recessives. When an individual carries a gene pair both components of which are similar (*e.g.*, TT or tt) he is said to be homozygotic; when the components are dissimilar (*e.g.*, Tt), he is heterozygotic.

Families have been described in which an occipital white lock is inherited as a sex-linked recessive. An affected male will not transmit it to his sons, but his daughters will transmit it to half their sons if married to a normal man ; if married to a man with the same character, half the daughters and half the sons will have it. This differentiates sex-linkage from sex-limitation. The shape of the female breast is doubtless subject to genetic control but the genes will only produce recognizable differences under adequate hormonal stimulation. Their effects are, therefore, limited to the female. One type of colour blindness is a sex-linked recessive, but affected women are known. Hæmophilia is certainly sex-linked and maybe sex-limited as well.

Sex itself may be said to be determined by the male, half his sperms carrying a Y chromosome and half an X chromosome. All ova contain an X chromosome. Theoretically, we should get one half XY (males) and one half XX (females) ; in fact, there is always a slight excess of males, the reason for which is unknown. However, it is not limited to wartime, as most people suppose.

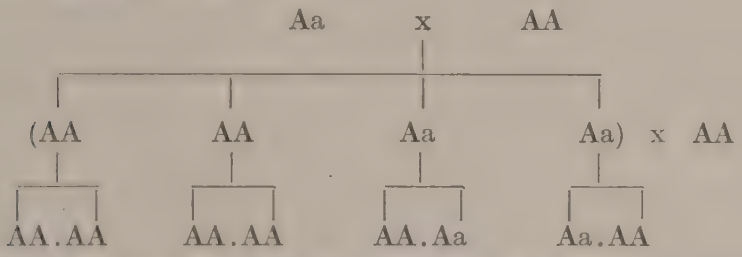
II. MATING

Random Mating. Apart from mass hybridization, the relative gene frequencies in a population can be upset by certain conditions. These conditions are : (1) great shrinkage in the size of the population. In small populations there may be great fluctuations in the gene frequencies ; also in small populations there is likely to be considerable inbreeding (see 5). (2) Selection. This means that one member of the pair tends to supplant the other. If M tended to increase infant mortality, N must obviously become more common, though the effect might take generations before it was noticeable. (3) Assortative mating. If like tends to marry like, this is called positive assortative mating ; the reverse is negative assortative mating. The former will tend to split the race into two dissimilar groups of homozygotes, the latter will tend to increase the proportion of heterozygotes. (4) A high mutation rate might upset the ratio, but this must occur very rarely if at all. (5) Inbreeding increases the proportion of homozygotes. If none of the above factors enters to an appreciable extent, we speak of random mating as occurring. So far as the respective gene series responsible for the blood groups, rhesus constitution, etc., are concerned, random mating may be said to exist.

Inbreeding. Most people are of the opinion that inbreeding is bad. Within certain limits this belief is justified, but it would be truer to say that inbreeding is dangerous. Indeed, on a long term view, inbreeding may have certain advantages.

The closest inbreeding in our society is between first cousins and the most striking risk is the production of people with undesirable recessive characters. Many of these cause such gross defects that they would rapidly be eliminated unless protected by their recessive nature. Others may have less drastic effects but these are little known.

Suppose an undesirable recessive gene has a frequency of 1 per cent. With random mating it will only occur as a homozygote with a frequency of one in ten thousand, whilst 1·98 per cent. of the population will be carriers.



Thus a man or woman has roughly a 2 per cent. chance of marrying somebody of the type Aa, as shown in the diagram. In the first generation homozygotic dominants and heterozygotes will have the same frequency and the frequency of ' a ' is 25 per cent. in the population so produced. If brother-sister mating occurred we should expect 6·25 per cent. recessives. However, all this generation are assumed to have mated with AA's. In the population of cousins so produced ' a ' has a frequency of 12·5 per cent. Marriages within such a population (if it were large enough) would give about 1·56 per cent. recessives. A number of rare recessive genes are known in man, and when we study their pedigrees, we find an excessive number of cousin marriages. Thus amongst the parents of albinos, the frequency of cousin marriages is 17 per cent., whereas in the general population it is probably about 1 per cent.

Eugenics. It would be generally agreed that it is desirable for healthy and intelligent couples to have larger families than they do, and that it is undesirable that those with gross defects should do so. Certain people go far beyond this, and see the only solution of our present political difficulties in selective breeding.

The rate at which selection will take effect is limited by the genetic basis of the characters in which we are interested. In the case of a single dominant gene, the incidence could be reduced to that of the mutation rate in one generation. With recessives the effect is far slower. This can be understood from the argument used in connection with the calculation of gene frequencies. Unless there is inbreeding, a relatively small percentage of the genes become unmasked in each generation, so that if the gene frequency is 1 per cent. and *all* homozygotes are eliminated, the frequency of the gene in the next generation is only reduced to 0·99 per cent. It can be calculated that it would take several centuries to reduce the frequency of such a gene from 1 to 0·5 per cent.

Characters depending upon single genes, are for the most part of no social importance (*e.g.*, blood groups) or if they are pathological, they are rare. The socially important characteristics are certainly determined by the combination of several genes and by the environment. Ignoring the latter, we can say that selection is bound to be slow in the case of characters determined by multiple genes, even when all of them are common. Suppose outstanding ability is determined by the simultaneous action of ten dominant genes, all of which have a gene frequency of 50 per cent., the desirable combination will only occur in 5·6 per cent. of the population. Even if these were to marry amongst themselves, they would not breed true, and only about one person in a million would be homozygous for all genes. It can be seen that any marked rise in the incidence of such desirable characters must be slow, even if we knew the genetic and environmental characters concerned.

III. POPULATION

It is not so many years since we were warned against the danger of over-population. To-day it is generally agreed that we are threatened with a catastrophic fall in population despite the fact that births still exceed deaths. This may at first sight appear paradoxical. The prediction is, however, based upon the fact that a population can only maintain itself by replenishing the supply of individuals in the reproductive age groups, which for statistical purposes may be taken as from 15 to 50. It may facilitate matters to consider two imaginary populations of 1,000 each. In the first, there are 800 old people of 50 or over, and 100 married couples of 20. Now 40 of the old people die every year, nobody dies under the age of 50, and 20 children are born every year.

TABLE 15

Imaginary Population with High Mortality over Fifty but with High Fertility

Number of people	Year				
	0	1	10	20	30
50 years and over	800	760	400	0	200
15 to 50 years .	200	200	200	300	300
Under 15 years .	0	20	200	300	400

In the first year we have 40 deaths and only 20 births; at 20 years, the population will have dropped to 600. Thereafter, some of the children will be entering the reproductive period every year. In 30 years, when the original 200 reach the age of 50, they will have replaced themselves by 300 young people born within the first 15 years. Some of these will have borne children between the twentieth and thirtieth year and it can be seen that the size of the population will have recovered in a little over 30 years. In short, with these conditions of fatality and mortality, each generation trebles itself. Even if everybody died on their fiftieth birthday, the population would be over a million in eight generations.

TABLE 16

Imaginary Population with Low Mortality and Low Fertility

Number of people	Year				
	0	1	10	20	30
50 years and over	400	395	350	300	850
15 to 50 years .	600	600	600	650	150
Under 15 years .	0	10	100	150	160

In Table 16 is shown another imaginary population in which the situation is apparently favourable. Here again nobody dies under the age of 50, only 5 die per annum over that age, but only 10 babies are born every year. After 30 years the population is still over 1000, but it consists mostly of people over the age of 50. The original reproductive generation of 600 is represented by only 300, who must produce the third generation. If these rates are kept up, the reproductive population will have virtually vanished in eight generations and such a population, even if nobody dies before the age of 80, will be doomed to extinction in about 300 years.

Models of the above type have their uses in demonstrating salient points in the same way as abstractions about perfectly smooth surfaces or perfectly true dice are of value in physics and mathematics. In order to bring these principles into relationship with real life, we must take into account mortality under the age of 50, the fact that fertility varies with age, and finally the significance of the term ‘generation.’ In the case of insects that breed once a year and then die, this is simple enough, but with human populations the generations overlap. One possible way round the difficulty might appear to be a study of the fertility of a number of women whose families were completed, either by death or the attainment of the menopause. This, however, would not give us much basis for predicting existing trends since fertility and mortality have changed radically within the last forty-five years.

The way round this impasse was largely developed by Kuczinski (1935), a simplified account of whose work is given by Charles (1934). The reasoning behind this work is as follows: fertility and mortality are subject to various environmental influences as well as being dependent upon age, even if the environment is kept constant. Now suppose in a given year girls between the ages of 15 and 19 have a birth rate of 215·6 per thousand, and between the ages of 20 and 24 a rate of 1,188·3 per thousand, we may argue that if the environment were to remain absolutely constant for the next 10 years, the original rates would be maintained. One thousand girls of 15 would produce 1,404 (215·6 + 1,188·3) children by the time they had reached the age of 25. These figures are those obtained in the Ukraine for 1926–27. If they are extended for the whole period of 15 to 50, the total children born per 1,000 women during the 35-year period amounts to 5,134·6 or 5·13 children per woman as she passes through the child-bearing age. This figure is called the gross reproduction rate.

It takes no account of mortality, and before this is allowed for, a certain simplification is permissible. Normally more boys are born than girls, but the mortality is less for female infants. Since the birth rate must ultimately depend upon the number of girls attaining reproductive age, we may legitimately neglect male mortality. The survivors per 1,000 newborn females may be obtained from the life table. For the Ukraine in 1926–27, 733 reached the age of 15. Now the number of children borne to girls of 15 worked out at 0·2 per thousand. Therefore their birth rate would be reduced from 0·2 to $(0{\cdot}2 \times 0{\cdot}733) = 0{\cdot}15$ per thousand, owing to mortality between birth and the age of 15. Similarly corrected, the birth rate at 16 drops from 1·6 to 1·18. For the whole 35-year period we get a correction from 5,134·6 to 3,461·7 per thousand women. In other words, if the environment remained constant for 50 years, every thousand women would produce 3,462 children, or 3·46 each. Here again, it is convenient to correct for sex, and in this case we find that they would have 1·68 girls each. This last figure is called the net reproduction rate. If it is over 1·0, the population will increase, whilst if it is under 1·0, it will diminish. In the two imaginary populations, we assumed an equal sex ratio and the net reproduction rates were 1·5 and 0·25 respectively. In England in 1933 the net reproduction rate was 0·734. Dr. Charles calculated that if this were maintained, the population would have sunk to just over 29 million by the year 2000.

In the two imaginary populations, it was shown that a low fertility tends to raise the average age of a population. This process is already apparent in England. In 1901, 29·6 per cent. of the population were aged 45 and over, and by 1935 the percentage had risen to 30·5. Since that time fertility has remained fairly low and it is certain that the proportion of middle-aged and elderly people in the population must increase considerably in the immediate future. It is well known that fertility varies within the population itself, the highest fertility being generally associated with a low standard of living. Some people are inclined to believe that this must lead to a deterioration in the quality of the population. Such fears are not based upon adequate genetic evidence, and there is no doubt that some at least of the imagined dangers could be eliminated by improving the environment.

P. A. Gorer.

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CHAPTER XIII

INFANT AND NEONATAL MORTALITY

The problems of infant mortality are intimately linked to those of population and birth-rate. Whilst many countries with a high birth-rate have also a high infant mortality, this is not necessarily the case, and before the recent war Holland was an outstanding example of a country with a high birth-rate and a low infant mortality. (In 1939 there were 20·6 births per 1,000 population and 34 infant deaths per 1,000 live births.)

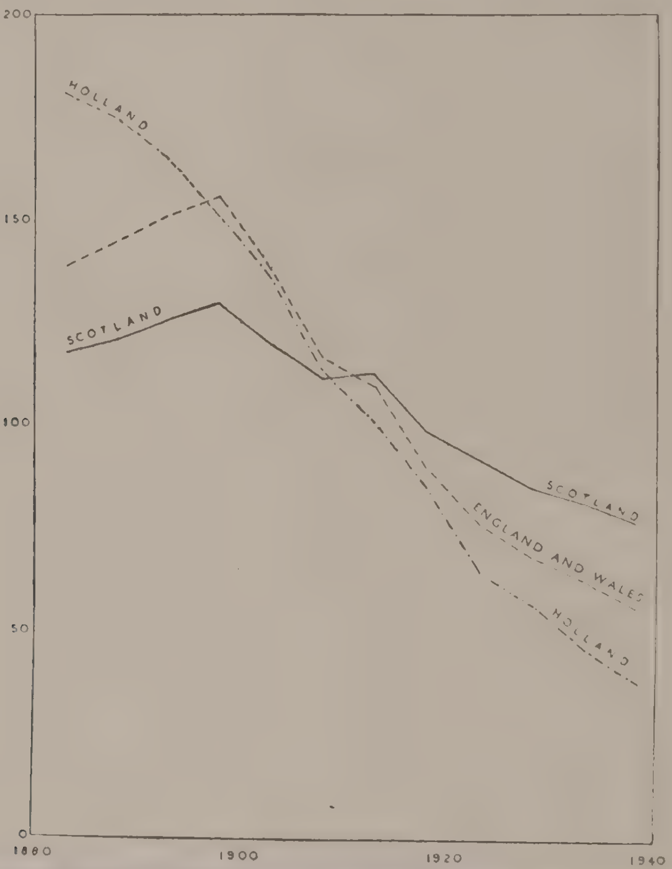

FIG. 44. Infant mortality rates, Scotland, England and Wales, and Holland, 1880–1940. (From 'Infant Mortality in Scotland,' 1946. Reproduced by permission of the Controller, H.M.S.O.)

In a country where the birth-rate is still dangerously low, it is obvious that particular attention should be paid to all factors which will reduce the still-birth and infant mortality rates; apart from humanitarian considerations, deaths during the first year represent a wastage which the community cannot afford.

Although there has been a remarkable fall in the infant mortality rate in England and Wales during the present century, from 163 per thousand live births in 1899 to 46 per thousand related live births in 1944, the figure still compares very unfavourably with that for Holland in 1939 or with recent figures for New Zealand. (The reduction in infant mortality in Holland is the more striking, since in 1880–9 the rate was 183 per thousand live births.) In Scotland the infant mortality, which at the beginning of the century was lower than that of England and Wales, is now substantially higher (see fig. 44).

Neonatal Mortality. In considering the causes of infant deaths, it is useful to subdivide the infant mortality into neonatal deaths, *i.e.*, deaths during the first month of life, and deaths during the subsequent eleven months. It is then seen that decline in infant mortality has affected the rate for the older age group to a much greater extent than it has neonatal deaths. Parsons (1945) has illustrated this by comparing the average annual death rate of infants aged one to twelve months for the years 1905–09 with that for the years 1938–42, and with the neonatal death rates over the same periods.

Average annual death rate (per 1,000 live births)	1905–1909	1938–1942
Neonatal (infants aged 0 to 1 month) .	41	28
Infants aged 1 to 12 months . .	81	25

It is therefore seen that the ratio of neonatal deaths to deaths during the subsequent eleven months has altered from 41 : 81 to 28 : 25. Whilst a certain proportion of neonatal deaths must still, in the present state of knowledge of their cause, be regarded as inevitable, there is undoubtably ample field for reduction of this loss of life during the first month. In Chicago, for instance, where the problem has been scientifically attacked, the neonatal death rate has fallen from 37 per thousand live births in 1925 to 25 in 1937 and 18 in 1940.

Definition of Live Birth. In comparing the neonatal and infant mortality figures of the British Isles with those of most other European countries, it should be realized that the British criterion of live birth is *beating of the heart* after birth, whereas most others adopt respiration as the standard. It follows that whilst all infants born in this country with the heart beating but in whom respiration is never established should be classified as live births and included in the neonatal and infant mortality statistics, elsewhere they might be classified as still-births. The American Academy of Pediatrics in 1935 urged the necessity of conforming strictly to the definition of live birth in compiling statistics—'All liveborn premature infants should be included, evidence of life being heart-beating or breathing'—but Barnes and Willson (1942) pointed out that it was still a common practice to exclude all infants dying within twenty-four hours from the category of live births. This is obviously undesirable if any satisfactory scientific approach to the problems of neonatal mortality is to be made.

Henderson (1945) has recently suggested the adoption of a lower limit of weight for prematures, below which they should be classified as 'pre-viable.' The weight suggested (2¾ lb. or 1,250 g.) was based on his estimate of the weight of the fœtus at twenty-eight weeks and the fact that an accurate correspondence exists between the metric and avoirdupois weights at this point. Whilst this might have statistical advantages, it should be realized that prematures weighing 1,000 g. and less may in fact survive (Hess *et al.*, 1934), and that other authors (*e.g.*, Crosse, 1945) have estimated the weight of the twenty-eight weeks' fœtus as low as 2¼ lb. (1,021 g.).

Causes of Neonatal Death. Many of these are the same as the causes of still-birth, and it is found that where the still-birth rate is high the neonatal mortality is also high (Baird, 1945). Prematurity is directly or indirectly responsible for over 50 per cent. of all neonatal deaths, though this condition is likely to be frequently associated with other factors such as intracranial hæmorrhage and atelectasis. Spence and Miller (1939), investigating the causes of 278 infantile deaths in Newcastle, found that 138 deaths occurred during the first month and 134 during the subsequent eleven months. Of the former, the three most important causes were classified as prematurity alone (47 cases), birth-death (38 cases), and infection (15 cases). They also concluded that in at least one-third of the total cases, the cause of death as given on the death certificate was inaccurate, a point to be kept in mind when conclusions are based on the Registrar-General's returns.

The importance of congenital abnormality as a cause of neonatal death varies to some extent with the still-birth rate, since it has been shown that as the still-birth rate falls, the death-rate from congenital deformity increases; this is presumably due to an increased number of infants with congenital deformities being born alive instead of being still-born.

Reduction of Neonatal Mortality. This may be attempted along three lines: (1) improved antenatal care, including improved social and economic conditions; (2) improved midwifery, since there are still a certain number of obstetric deaths which are preventible; and (3) improved care of the newborn. This last will include greater provision being made for premature infants, although reduction of the incidence of prematurity should obviously be the primary aim. The prevention of neonatal infection is probably of more importance than many of the published figures indicate, since infection in the neonatal period is often difficult to diagnose and liable to pass unrecognized.

To these three might be added 'Marriage and reproduction during the period of maximum fertility.' Baird found that the still-birth rate was least in women under twenty-five years of age, and with each parity rose with age. The neonatal mortality showed a similar trend, though the changes were less striking. He also found that rapid child-bearing, up to the fourth or fifth pregnancy, did not appear to increase the risk to the child provided that the mother was young. ('Young' in this sense is of course relative, the prospect of successful child-bearing being greater at the age of twenty than at seventeen or eighteen.)

Finally, it should be emphasized that the mother's fitness for child-bearing will be influenced not only by age and care during pregnancy, but by her diet and economic status from infancy. One of the most striking lessons of the recent war was that infant mortality was reduced under a system of strict rationing when a restricted food supply was equally distributed, whilst at the same time unemployment was eliminated. Although such maternal conditions as contracted pelvis due to infantile rickets are now a less common cause of neonatal mortality and still-birth than during the nineteenth century, there is still a great field for the improvement of the general nutrition and physique of large sections of the community, and a prospect of lowering neonatal mortality by this means. Titmuss (1943) has brought forward evidence that although the infant mortality and still-birth rates amongst the poorest social groups have been reduced, they are now relatively higher than before in comparison with those of the groups more favoured economically.

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CHAPTER XIV

THE INFANT WELFARE MOVEMENT

Historical [1]

The middle of the nineteenth century had been marked by a growing concern over the exploitation of child labour and the savage sentences often passed on young children (*e.g.*, in 1877 a child of eleven had been condemned to hard labour for stealing a leek valued at 4d., and the sentence was only remitted by the efforts of a voluntary society). Legislation had been introduced for the protection of children in employment, but only after bitter opposition. Thus a Bill introduced by Lord Shaftesbury in 1853, following the death by suffocation of two little boys employed as chimney-sweeps, was rejected by the Lords, having been opposed by Lord Beaumont as 'pitiful cant of pseudo-philanthropy.'

It was not until nearly the end of the century, however, that the general public began to appreciate the appalling wastage represented by the high infant mortality, or that any general measures were taken to remedy it. A few enlightened individuals had, of course, drawn attention to the matter very much earlier. Thus in 1748 the committee of the Foundling Hospital published a pamphlet by Dr. William Cadogan entitled 'An Essay upon Nursing and the Management of Children from their Birth to Three Years of Age,' which contains much excellent matter. The author drew attention to the high mortality of children under five years of age, and the public indifference to it. Of infant feeding, he states: 'If we follow Nature, instead of leading or driving it we cannot err. . . . The general Practice is, as soon as a Child is born, to cram a Dab of Butter and Sugar down its throat, a little Oil, Panada, Caudal, or some such unwholesome Mess. So that they set out wrong, and the Child stands a fair Chance of being made sick from that first Hour.' In 1769 a 'Dispensary for the relief of the Infant Poor' was opened in London by Dr. John Armstrong. By 1781, some thirty-five thousand infants had been treated at this dispensary, and it was said 'no charitable institution was established whereby so much good has been done, or so many lives saved at so small an expense.' Owing to the illness of the founder, lack of financial support, and public indifference, this pioneer Infant Welfare Centre was subsequently abandoned. A similar dispensary was opened in 1816, after ten years untiring and largely unsuccessful effort to interest leaders of the medical profession, by Dr. J. B. Davis ; again, a pioneer in advance of his time, Davis was a staunch advocate of breast-feeding, and taught : ' The Mother's Breast is an Infant's Birthright and Suckling a Sacred Duty, to neglect which is prejudical to the Mother and fatal to the Child.' He even included Health Visiting in his Infant Welfare programme, and it is lamentable to realize that nearly a century passed before the principles he advocated found any general acceptance.

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[1] Acknowledgement is made to G. F. McCleary's 'The Early History of the Infant Welfare Movement' (1933, London, Lewis) for much of the historical information.

Practice of Midwifery. The first scientific enquiry of statistical importance relating to infant mortality in this country was carried out by Dr. William Farr in 1867–69 in collaboration with the Obstetrical Society of London. The result of a questionnaire to members of the society indicated that 50 to 75 per cent. of births in England and Wales were at that time attended by midwives, and that these midwives were almost entirely uninstructed. As a result, the Society began a campaign to press for the proper instruction, examination, and certification of midwives, which was to lead to the foundation of the Midwives Institute (now the College of Midwives) in 1881, and, after several unsuccessful attempts, to legislation in the form of the Midwives Act (1902) ; this included an amendment prohibiting the practice of midwifery by unregistered women, which was to become operative in 1910. The Central Midwives Board was established when the Act was passed, as the statutory body governing midwives in England and Wales. During the succeeding years, the standard of training and practice, and consequently the status, of midwives have been raised to a degree which would have appeared unbelievable at the time of the Farr enquiry. The introduction of routine antenatal supervision during pregnancy and the special training of midwives in the care of newborn and in infant feeding has undoubtedly played a great part in the fall in neonatal mortality during the present century.

Baby-Farming and the Protection of Infant Life. Shortly after the Farr enquiry, the public conscience received a further rude awakening by the trial and execution in 1870 of Margaret Waters, a notorious baby-farmer. The practice of baby-farming, which had already been exposed by Dr. Curgenven before the Harveian Society and in the *British Medical Journal* by Dr. Ernest Haw, and against which Lord Shaftesbury had attempted to persuade the Government to take action, was at that time not only uncontrolled, but was in many hands little more than systematized infanticide of illegitimate and unwanted infants. The Society for the Protection of Infant Life, which was founded in 1870, estimated that the mortality of babies entrusted to baby-farmers was between 60 and 90 per cent. The society was largely responsible for the passing of the Infant Life Protection Act in 1872, by which the registration was made obligatory of persons receiving two or more infants under one year for hire, whilst the passing of the Births and Deaths Registration Act in 1874 was a first step in eradicating the anonymous infanticide of infants born in unregistered lying-in homes. (The registration of such homes was not made obligatory until the passing of the Midwives and Maternity Homes Act in 1926.) That the Infant Life Protection Act of 1872 was frequently evaded was again forcibly brought home to the public by the trial in 1896 of Mrs. Dyer, a lady of the same kidney as Margaret Waters, who was proved to be in the habit of strangling the babies with whom she was entrusted, and throwing their bodies into the Thames. The following year the Infant Life Protection Act (1897) was passed, and was subsequently superseded by the Childrens Act (1908) and Childrens and Young Persons Act (1933). This last is of very wide application, and covers (1) prevention of cruelty and exposure to moral and physical danger, (2) employment, (3) protection of children and young persons in relation to criminal and summary proceedings, and (4) remand homes, approved schools, and persons to whose care children and young persons may be committed. The Adoption of Children (Regulation) Act (1939) was introduced ‘to regulate the making of arrangements by adoption societies and other persons in connection with the adoption of children; to provide for the supervision of adopted children by welfare authorities in certain cases; to restrict the making and receipt of payments in connection with the adoption of children,’ and to amend previous adoption Acts. Although the lot of illegitimate and unwanted children has undoubtedly been greatly improved by legislation and public and private effort, it is still far from satisfactory (see Chapter XVIII); to take only one example, the relative infant mortality from diarrhœa and enteritis amongst illegitimate babies in the Greater London area in the years 1930–38 was more than three times as great as that of legitimate infants (24·61 as compared with 7·63 per 1,000 live births).

Infant Feeding and Provision of Clean Milk. The infant welfare movement received sudden impetus in France, America, and England at about the same time. Pierre Budin, Professor of

Clinical Obstetrics at the Charité in Paris, was responsible for founding the famous *Consultations des Nourrissons* in 1892, and for the last fifteen years of his life devoted much of his time and energy to the encouragement of breast-feeding and supervision of infant hygiene. Other infant clinics were soon founded independently of maternity hospitals, and of these Dr. Dufor's '*Goutte de Lait*' was most successful in appealing to the public imagination; these pioneer clinics served not only to develop the infant welfare movement in France but their influence spread to many other countries in Europe.

In America the evolution of the Well Baby Clinic was largely due, in the first instance, to the efforts of the milk reformers, who in the last decade of the nineteenth century were divided into the advocates of the certified milk movement (founded by Dr. H. L. Coit) and those who advocated compulsory pasteurization. Of the latter, Nathan Strauss was an outstanding example of public spirit and practical ability. Having realized that the high infant mortality in New York was largely due to gastro-intestinal disease, he decided to start a milk depot where working-class mothers could buy, at slightly less than cost price, pasteurized milk that was either undiluted or modified for infant feeding. The scheme was carried out with medical co-operation, and was so successful that it rapidly expanded beyond the limits of private philanthropy; in 1913 two-thirds of the seventy-seven milk depots in New York had been opened by the Public Health authorities.

In England, as in America, it was the persistently high infant mortality which alarmed the more enlightened members of the community and stimulated the formation of the modern infant welfare movement. Although the death rate as a whole had fallen during the latter part of the nineteenth century, the infant mortality in England and Wales was found to show little or no corresponding diminution, and in 1899 it was the highest ever recorded, namely, 163 per thousand live births. There is no doubt that the infant welfare movement in France had a profound influence on the initiation of a similar movement in England, and the work of the pioneer centres in France was made known to an increasing public in England by lectures, articles and conferences. St. Helens opened the first milk depot in 1899, and during the succeeding years an increasing number of similar depots were opened throughout the country. These were in some instances started by voluntary effort and in others by municipal authorities; free meals for nursing mothers were provided in certain centres. The St. Pancras School for Mothers, the first of many of its kind, was opened in 1907, and instruction given in infant hygiene and domestic science. It received a monetary grant from the Board of Education in 1908. The establishment of infant consultations was given a considerable impetus by the first National Conference on Infantile Mortality and the foundation of the National Association for the Prevention of Infant Mortality in 1906, and by the publication of Sir George Newman's classical work on this subject in the same year. In 1914 the Board of Education and Local Government Board were empowered to make Exchequer grants on a wide basis for maternity and child welfare work, and in 1918 the passing of the Maternity and Child Welfare Act established the movement on an official basis. The Act was, however, only permissive ; local authorities were therefore given governmental support in undertaking child welfare work, but were not obliged to provide a comprehensive service. Much of the work remained under voluntary control. The National Association of Maternity and Child Welfare Centres (later incorporated with the National Association for the Prevention of Infantile Mortality) was founded in 1912, and now forms one of the nineteen constituent bodies of the National Council for Maternity and Child Welfare, whose objects are : (1) to coordinate and assist the work of the various national and local voluntary organizations concerned in the care of motherhood, infancy and childhood ; (2) to assist in the establishment and maintenance of such residential institutions as the Constituent Bodies may from time to time find necessary ; and (3) to promote a standardization of training for social welfare workers in connection with motherhood, infancy and childhood. Apart from its assistance to local organizations, the National Association has since its foundation been responsible for bringing the work of the maternity and child welfare services to the attention of the general public, and has sponsored many publications on infant hygiene and feeding.

Health Visiting. Whilst the establishment of milk depots and infant consultations owed much to the example of France and America, health visiting is (as pointed out by McCleary, 1935) a most important British contribution to the infant welfare movement. Organized health visiting was begun by the Ladies' Sanitary Reform Association of Manchester and Salford in 1862, and was carried out at first by voluntary and later by salaried visitors. The work was so successful that the example was followed in other parts of the country, although it was not until 1892 that a local authority (in this case the Buckinghamshire County Council) employed salaried visitors, who had undergone a course of instruction. Florence Nightingale, who saw great possibilities in the organization of health visiting, was largely responsible for the introduction of systematic instruction. In the early days, the visiting of mothers with newborn infants was carried out under considerable difficulty, since there was no obligatory notification of birth within a specified period. With the passing of the Notification of Births Act (1907) and the Notification of Births (Extension) Act (1915), it finally became obligatory to notify births of infants of over twenty-eight weeks' gestation within thirty-six hours, and visiting during the neonatal period could be carried out on a much more compehensive scale.

The training of health visitors was at first haphazard, and voluntary bodies might appoint women with a variety of qualifications, including sanitary inspectors, doctors, midwives, trained nurses, or those considered suitable on grounds of personal experience. The requirements gradually became regularized, and the certificate examination was placed entirely in the hands of the Royal Sanitary Institute. Until recently, candidates were required to be *either* (1) trained nurses (general, fever, or sick children nurses' training), holding the certificate of the Central Midwives Board, and having carried out an approved course of training in public health work, lasting at least six months, *or* (2) women who have undergone an approved course of training in public health lasting for two years, together with six months in hospital and who have obtained Part I of the certificate of the Central Midwives Board, requiring in this instance one and a half years' training. The special training under (1) is now being increased to a minimum of nine months. It will be seen that under the new regulations the Health Visitor will require a total training of over four years, a recognition of the extreme importance of her work in promoting the health of the community.

The Maternity and Child Welfare Service

From what has been said, it will be seen that the problems of reducing infant mortality and of the promotion of child health have been approached along the following lines :—

(1) The establishment of infant consultations.

(2) The provision of clean milk for infants and free meals for nursing mothers.

(3) The improvement of midwifery practice and training, and provision of antenatal care.

(4) Health visiting, starting in the neonatal period, and including instruction in mothercraft.

As in the case of most measures for social progress, the first moves have been initiated by independent voluntary bodies, subsequently adopted by municipal authorities, and finally supported by legislation.

The passing of the Maternity and Child Welfare Act in 1918 represented the formal recognition both of the value of the four lines of approach and of the fact that they are mutually inseparable. Whilst the obstetrician and the midwife on the one hand and the pædiatrician and infant welfare worker on the other have their particular parts to play in the general scheme, fœtal development, birth, and infant life and development are all stages in the life of the same individual. It follows that antenatal care, midwifery, and infant supervision must be closely integrated; the midwife must understand the care of the newborn infant and the infant welfare worker the care of the infant before it is born. This principle is put into practice by the combination of infant welfare centres with antenatal clinics. Unfortunately, it is not always the case that the midwife or doctor who delivers the baby is the one who is responsible for the antenatal supervision, but considerable progress has been made along these lines, and it is to be hoped that with the establishment of a comprehensive national health service the liaison between maternity clinics and infant welfare centres will be increasingly close.

It should be emphasized that the Maternity and Child Welfare Act is still only permissive, and whilst many social authorities have established extremely efficient maternity and child welfare services (usually with an assistant medical officer of health in charge of both), others lag seriously behind. The Act is administered centrally by the Ministry of Health, which in addition to full-time officers has set up an Advisory Committee on Maternity and Child Welfare, and locally by the local health authorities. The latter are empowered to organize services 'for attending to the health of expectant mothers and nursing mothers, and of children who have not attained the age of five years and are not being educated in schools recognized by the Board of Education,' and in so doing are required to set up a local maternity and child welfare committee. The scope of the work envisaged was set out by the Local Government Board in 1919 as follows :—

(1) A health visiting staff sufficient to supervise the expectant and nursing mothers and infants and children under school age in the district who need visiting, to make special visits to children suffering from infectious diseases, and to assist at the centres attended by mothers and infants. (The number of whole-time health visitors required per 1,000 annually has not been arbitrarily

fixed, since conditions in rural and urban areas are not comparable. One visitor to every 250–400 live births per annum has been suggested, but some local authorities have been able to provide a considerably higher proportion of visitors than this.)

(2) A maternity and child welfare centre to serve the district of each health visitor in populous areas at which hygienic and medical advice are provided for expectant and nursing mothers and for infants and young children.

(3) Provision of food and milk for expectant and nursing mothers and infants and young children needing nourishment, which they cannot afford to buy for themselves.

(4) An adequate service of trained midwives.

(5) Arrangements for securing the prompt attention of a doctor when a midwife needs medical assistance in illness connected with pregnancy and confinement.

(6) A service of nurses for illness of pregnancy, puerperal fever, ophthalmia neonatorum, measles, whooping cough and epidemic diarrhœa in young children.

(7) Hospital accommodation for acute illnesses connected with pregnancy, confinement, and infancy.

(8) Maternity homes and homes for infants suffering from malnutrition and other similar conditions which are not ordinarily admitted to hospitals.

(9) Convalescent homes for women after confinement and for infants and young children, and rest homes for expectant mothers in certain cases.

(10) Accommodation in homes or other arrangements for attending to the health of widowed, deserted or unmarried mothers.

(11) Provision in day nurseries, crèches or otherwise for looking after children of women who go out to work.

(12) ‘ Home helps ’ for taking care of the home during the period of confinement.

The growth of the maternity and child welfare services has continued even in spite of the war years, and has been associated with a continued reduction in infant mortality. At the end of 1943 in England and Wales there were 3,825 infant welfare centres open, of which 2,994 were run by local authorities and 831 by voluntary associations, whilst the number of women receiving antenatal supervision through clinics or by arrangements made by the welfare authorities was 542,177 or 77 per cent. of total registered births. The number of children under one year who attended clinics for the first time in 1943 was 469,324 (68·7 per cent. of total registered live births) and the number of first visits paid by health visitors to children under one year during 1943 was 661,629 (96·8 per cent. of total registered live births).

During the war years, the Government's nutritional policy included a system of priorities for nursing and expectant mothers, and children under five, and under the National Milk scheme these each received a pint of milk a day. Free distribution of vitamin supplements, *i.e.*, vitaminized oil, concentrated orange juice or black currant purée, was also organized through the welfare centres, though the take-up of these supplements was disappointing.

The Organization of an Infant Welfare Centre

The size and staff of the centre will obviously depend on local circumstances, and whilst in sparsely populated rural areas it may only be possible to hold a clinic once a week, or less frequently, in a borrowed building, in urban areas it is preferable to have a specially constructed building and to have the centre open every day. It should always be borne in mind that the best results will be obtained when the mothers come to look on the centre as a 'mothers' club,' in which they have a personal interest, and for this reason there is much to be said for the system by which they help to raise part of the funds themselves. The personality of the superintendent and staff is of the utmost importance, since it is essential that mothers should feel that they can look for personal interest and friendliness as well as technical advice. It is also advisable to avoid too much of the 'clinic' atmosphere in the furnishing and equipment. Thus it may be hygienically admirable to give a mother instruction in breast-feeding whilst she is sitting on a specially designed chair in a curtained cubicle fitted with hot and cold water, but she is more likely to carry out the instructions at home if conditions are a little more in keeping with those she is used to.

No centre is any the worse for having begun modestly in whatever accommodation might be available. (One South London clinic, for instance, was run very successfully for many years in a disused public house, whose name it retained.) When a new centre is being designed, however, provision should be made for the following :—

Outside. A pram park, and sufficient open space for toddlers to play in, and in which babies can be put out to sleep.

Inside. (1) A comfortably furnished waiting room and lounge, where health talks and demonstrations can be held and where pregnant and nursing mothers can rest.

(2) Undressing and weighing room, fitted with receptacles for children's clothes. (Clothing can, for instance, be stored in paper-bag containers on racks.)

(3) Canteen and kitchen, for serving teas on clinic days and meals to nursing mothers; this can also be used for cooking demonstrations.

(4) Breast-feeding room.

(5) Superintendent's office and record-room.

(6) Dispensary and store for dried milk, etc.

(7) Doctor's consulting room, equipped both for infant consultations and with cubicles for antenatal consultations.

(8) Isolation cubicle, for cases of suspected infectious disease awaiting examination or disposal.

(9) Treatment room, for minor ailments.

(10) Bathroom; staff and patients' lavatories.

(11) Dental treatment room.

If practicable, the whole clinic should be on ground-floor level.

Staff. The medical officer, attending on a sessional basis, will see each new baby on its first attendance, and as often subsequently as he considers necessary.

The superintendent, who should be a health visitor, and who in a large centre will be in the centre each day, will give health talks and demonstrations and instruction in breast-feeding, and supervise the work of the health visitors.

One or more health visitors will carry out the visiting and assist with the weighing and records on clinic days.

Where dental treatment is provided, a dentist will attend on a sessional basis.

In some rural areas, the district nurse holds the Health Visitor's Diploma and acts as superintendent of the clinic. In other cases she assists the health visitor on clinic days and gives minor treatment. It is often possible to enlist voluntary helpers to assist with the weighing, records, and serving of teas.

The Work of the Centre. This is essentially preventive and educational, and only minor ailments such as impetigo, napkin rashes, and feeding disorders are actually treated at the centre, though in some cases ultra-violet light treatment and remedial exercises may be given. The centres are responsible for seeing that infants requiring other treatment are referred to their general practitioner or to hospital. It has been found, however, that the provision of dental treatment for both mothers and toddlers has been of very great value in many centres, and this service is now often included in the work of the centre.

Infant consultations are held at fixed times, when new attenders and also those cases which require medical supervision are seen by the medical officer at least once a month, and after this age by the medical officer. Infants under a year old are usually seen every two to three months if they are progressing satisfactorily. At their other attendances they are weighed and seen by the superintendent or other health visitor, the younger infants attending once a week for this purpose.

Records. A case-sheet including a record of the weight, feeding, medical examinations, and clinical notes is kept at the centre for each infant attending. The mother should also keep a weight-card, which is entered up on each attendance.

Provision of Milk and Meals. Milk can be supplied at cost price (or free in necessitous cases) for nursing mothers and artificially fed infants. It is usually found that dried milk is the most convenient form in which it can be supplied. Vitamin supplements are also supplied for infants, and it is part of the work of the clinic to make sure that they are given as required. In some clinics, free meals are supplied for necessitous pregnant or nursing mothers, or the service may be extended to provide meals at cost price to mothers considered likely to benefit from them. This is often of great value to nursing mothers after the puerperium. Only a few simple drugs are supplied at the centre, and dispensing of anything except foods is not encouraged.

Breast-feeding. The encouragement of breast-feeding is one of the main objects of the infant welfare centre. It is a great advantage if the centre is open every day, so that mothers who are having difficulty with breast-feeding can attend for test-weighing of the infants for at least three feeds, and can receive advice in technique from the superintendent.

Health Talks and Mothercraft Training. Health talks and demonstrations covering the various aspects of infant hygiene, demonstrations of cooking, and sewing classes or meetings should be held at least once a week and are usually a popular feature of the work. The purpose of vaccination and diphtheria immunization should be explained, and every effort made to encourage the mothers to take advantage of the facilities provided. The use of instructional films has been found a great attraction in some centres.

Health Visiting. Since the health visitor cannot enter the house unless the owner is willing, it is essential that health-visiting should be carried out with tact, and that it should be clear that the object is to help and not to pry. The notification of births in the district is received from the medical officer of health, and if possible the first visit should be made during the neonatal period.

At this visit the mother is given the address of the welfare centre and encouraged to attend as soon as she is able to do so. Since a considerable proportion of infants are taken off the breast before the end of the first month, it is of great importance that the first visit should be paid early.

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CHAPTER XV

THE SCHOOL MEDICAL AND DENTAL SERVICES

Historical

Elementary education was made compulsory in England by the passing of the Education Acts of 1870 and 1880.[1] The inclusion of children from the poorest homes within a national educational service made evident, however inadequate the teaching and supervision, that a considerable proportion were unable to benefit from such educational facilities either on account of physical defects or malnutrition. A survey undertaken in 1880 indicated that in the London area alone there were approximately 50,000 children (10 per cent. of those attending school) who were actually 'too hungry to learn.' Various voluntary organizations undertook the provision of free meals in necessitous cases, but as is liable to be the case in pioneer voluntary work, the service was unco-ordinated and provided no complete solution to a problem of such magnitude. In 1906 the Education (Provision of Meals) Act was passed. This made it possible for free meals to be obtained in necessitous cases through the education authorities, and subsequently for school meals to be provided at a low rate of payment in other cases; the Education Act (1944) covers the provision of school meals on a much wider basis than hitherto (see below).

The educational and national wastage due to physical defect was recognized in the passing of the Elementary Education Act (Defective and Epileptic Children) in 1899, which made it obligatory for the education authorities to determine what children under their care were physically or mentally defective. Little was done to implement the Act, however, for the next three years, although a few of the more enlightened education authorities had already initiated school medical examinations before the Act was passed. Even these seem to have had little conception of the magnitude of the work involved. For example, one part-time medical officer holding some thirty-two other appointments had been delegated to cover the school medical work for nearly half a million children in the London area. The first full-time medical officer was appointed by the London School Board in 1902, and he soon made it clear that there was much that was profoundly rotten in the state of London's children.

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[1] The Act of 1870 made it possible for local authorities to enforce attendance, whilst the Act of 1880 introduced compulsory education throughout the country.

It was not, however, until the nation had been shocked by the incidence of preventible disease revealed by the recruiting figures for the Boer War in 1902, that it was generally realized that unless the detection and correction of physical defect was seriously tackled in the school age, the country would rapidly become as unfit for the arts of peace as it was for the craft of war. Later, it became apparent to school medical officers that much avoidable damage had already been done by the time the children first entered school, and since the passing of the Maternity and Child Welfare Act in 1918 there has been an increasingly close liaison between the school medical service and those caring for the health of the pre-school child. (It should be pointed out that although the Maternity and Child Welfare Service is administered by the Ministry of Health and the School Medical Service by the Board of Education, the Chief Medical Officer to the Ministry of Health is also the Chief School Medical Officer, and in most local authorities the liaison between the two services is usually equally close, the Medical Officer of Health being the School Medical Officer. The position in London is peculiar, since the school medical service is the responsibility of the London County Council, whereas the Maternity and Child Welfare Services are administered by the local boroughs.)

The original policy of the school medical service was to detect those children with physical defects rather than to provide treatment, but with the passing of the Education Administrative Provisions Act, 1907 (Medical Inspection and Treatment) it became possible for local education authorities to provide facilities for treatment. This was done in the first instance by arrangement with local hospitals serving as consulting centres; in London, such an arrangement was established in 1909 with six hospitals (including two general and two children's hospitals, the Royal London Orthopædic Hospital and the Royal Eye Hospital), which covered the treatment of 26,000 children a year out of a school population of approximately 700,000. A capitation fee was charged by the hospital concerned, and in the absence of a follow-up service this provided the only check on whether treatment had been sought when recommended by the school medical officer.

It was soon found uneconomical and unnecessary for the treatment of minor ailments to be carried out at consulting centres, and in 1910 the first school treatment centre was opened in

Hampstead. This was established under the direction of a committee of local general practitioners, the education authorities thus carrying out the policy of providing facilities for treatment but not undertaking the treatment within their own medical service.

With the appointment of school ‘ organizers,’ the establishment of a follow-up system, and the setting-up of care committees under the local education authorities, the consultative services and work of the school treatment centres grew until in 1939, in the London area, there were ninety-nine hospitals and treatment centres providing treatment for 313,245 cases a year.

Outside the London County Council area, the rate of progress and efficiency of service varied greatly in different localities, partly due to the enterprise or otherwise of the local education authorities and partly to the existing voluntary hospital and public health services. The problems of providing facilities for consultations are obviously much greater in a sparsely-populated rural area than in a large municipal one in which there is already an efficient and well-staffed voluntary hospital service available. In the latter, the development of the school medical service has usually been along much the same lines as in the L.C.C. area, though the system of school organizers actually attending the hospital consultative clinics, making the appointments and carrying out the follow-up has not reached the same degree of development elsewhere. In areas where hospital consultations have been impracticable, local consulting services for orthopædic, ear, nose and throat and eye cases have been made available by local health authorities. Up to the present time, however, comparatively few counties or municipalities have appointed full-time consultants in children's diseases, and in many parts of the country no facilities whatever are available for referring school-children to a pædiatrician. The Education Act of 1917 had made it optional for local authorities to provide treatment, and this was made obligatory in 1918 as regards elementary school-children, whilst the optional power was extended to cover all children attending school, irrespective of whether the schools were aided by the educational authorities or not. Full use of the optional powers has been made by the more progressive local authorities, whilst in the more reactionary areas even the compulsory provisions of the 1918 Act have been inadequately implemented. Up to April, 1945, the local education authorities charged parents who could afford to pay for treatment received, but the Education Act of 1944 embodies the principle that all school-children are entitled to free treatment, making this the responsibility of the local education authorities. It is at present premature to say how the details will be worked out with regard to the *rôle* of the school medical service as part of a comprehensive National Medical Service.

Dental inspection and the provision of dental treatment have lagged behind the other child health services, but immediately before the war the School Dental Service was expanding more rapidly than any other. The early difficulties were partly due to a shortage of qualified dentists and partly to ignorance and apathy on the part of the parents who were disinclined to let their children receive dental treatment when this was available. In 1910 the London School Board appointed an inspecting dentist, but was at that time unwilling to finance any experiment in treatment. The early efforts to secure the attendance of children requiring treatment at existing dental dispensaries were lamentably unsuccessful, but it was subsequently possible to start a privately-financed dental clinic for school-children at St. George's Dispensary, Blackfriars, which, with the co-operation of the local Care Committee gave more promising results. Active propaganda with regard to dental health has, during the succeeding years, undoubtedly served a useful purpose in making school-children, parents, and local authorities more aware of the importance of early treatment. By 1939 a school dental scheme was in operation, which aimed at the annual inspection of all school-children and the general availability of dental treatment. It cannot be said that even the modest aim of an annual dental inspection had been fully realized in all rural areas when the outbreak of war caused serious dislocation of the civilian dental services, but in many parts of the country the school dental service had reached a high pitch of efficiency reflected in the improved dental health of the younger generation. That this was highly necessary as recently as 1934 is indicated by Reports on the Health of the Army and Navy for that year, when it was stated that 98 per cent. and 96·8 per cent. of army and naval recruits respectively required dental treatment, whilst the Health of the Air Force showed that each recruit accepted (representing a selected intake) required an average of 5·1 fillings. But whereas in 1901 in the L.C.C. area, 96 per cent. of children qualifying for scholarships were found to require dental treatment, in 1939 the percentage had fallen to 4 (Gibbon and Bell, 1939).

The School Medical Service during the present century has thus evolved along the following lines :—

(1) The regular medical and dental inspection of school-children.

(2) The establishment of school treatment centres (for dealing with minor ailments) and of school dental clinics.

(3) The reference of children requiring more specialized treatment or investigation to hospital or special consulting centres, or to their medical practitioner.

(4) The provision of special schools for children suffering from visual defects, deafness, mental retardation, epilepsy, and certain other chronic disabilities.

(5) The setting up of care committees.

(6) The provision of school meals.

In each direction, the work has in the first instance been started either by voluntary effort or by local authorities acting on their own initiative; this has been followed by 'permissive' legislation, enabling local authorities to obtain exchequer grants for certain parts of the work undertaken; and finally local authorities have been *required* by Act of Parliament to undertake increasing responsibilities for the health of school-children under their care. This method of progress of the school medical service has led to enterprising local authorities becoming very much in advance of the more reactionary, and the general advance has not been along an even front but more in the manner of the amœba by the pushing forward of pseudopodia. In general, the rural areas with a scattered population and greater difficulties of transport are considerably less well served than the larger municipalities, but progress has not necessarily been commensurate with the wealth or poverty of the local authority.

Medical and Dental Inspections

These comprise 'routine' and 'special' inspections. Whilst the Education (Administrative Provisions) Act of 1907 made it obligatory for local authorities 'to provide for the medical inspection of children immediately before or at the time of or as soon as possible after their admission to a public elementary school, and on such other occasions as the Board of Education direct,' the Board of Education (Circular 576, 1907) made it clear that not less than three medical inspections during the school life of the child would be necessary. The re-inspections were intended to take place at the ages of eight and twelve years. In the L.C.C. and many other areas the number of routine inspections has been increased to four, whilst in others even the aim defined in 1907 has not yet been attained in practice. Whilst the increase in the number of routine inspections carried out has been relatively slow since the school medical service was established, and has suffered unavoidable set-backs during the two wars, the number of special examinations, carried out on the recommendation of the head teacher or school nurse, or on account of some defect discovered on routine inspection, has shown a very great increase. Thus in 1936 it was reported (Chief Medical Officer, 1936) that in the previous ten years there had been an increase of about 65 per cent. in the number of special inspections, and that in that year there were 83 special inspections for every 100 routine examinations.

The routine medical inspection in the case of small or ill-equipped schools is best carried out at a central school clinic or health centre, since this is considerably more efficient from the point of view of medical and nursing personnel, records, and apparatus. In areas where this is not possible, the examinations will have to be carried out on the school premises. The school nurse, a representative of the care committee, and a responsible teacher who knows the children individually should be in attendance.

Each child, on its first inspection, has a card made out by the teacher giving particulars of name, address and date of birth; previous illnesses and exanthemata, and any relevant family history should be entered on the record card, but the taking of a medical family history by the teacher is undesirable, and should be the responsibility of the doctor, nurse, or health visitor.

Height and weight should be measured by trained personnel under the supervision of the medical officer; these measurements are not the responsibility of the teacher, and the undressing of children should be the responsibility of the school nurse. Boys are usually weighed in shorts and girls in knickers, but in badly heated premises there is often considerable variation in the clothing worn and the value of the weight records correspondingly diminished. When specially designed and heated premises are available it is preferable that children under eleven should be weighed naked. It is essential that the balance should be regularly checked and kept in good order.

Physical examination includes the testing of visual acuity and hearing (for both of which the co-operation of the teacher in the case of younger children is often necessary), assessment of general nutrition and posture, examination of head and body cleanliness with particular reference to pediculosis, scabies, impetigo and ringworm, examination of ears, nose and throat, heart, lungs and abdomen. Orthopædic and postural deformities (kyphosis, scoliosis, pes planus, etc.) should be noted, and the child examined for hernia, phimosis, or undescended testicles. The teacher's observations on the child's behaviour in school will often reveal neurotic reactions or mental retardation which might otherwise be overlooked on the routine examination.

Any children requiring special care in school will be notified to the teacher, and a note made on their record card, whilst those who require further treatment or investigation will be referred to the school treatment centre or appropriate consulting centre, or put down for special examination later. The school organizer or representative of the care committee is responsible for seeing that appointments are made and that if they are not kept, of seeing that the parents have explained to them the necessity for treatment. A system of consultation cards, on which the school medical officer writes his reasons for referring the child in one column, and the consultant his reply in another, greatly facilitates continuity of treatment.

Considerable responsibility rests with the school medical officer, particularly with regard to such recommendations as operation for tonsillectomy. Although, theoretically, the case should subsequently be assessed by a nose and throat specialist, who will decide whether he also considers the operation advisable either at that time or later, in practice there is a real danger of such children being admitted direct to a 'tonsillectomy clinic' without the surgeon having seen the child before operation. It is unfortunately the case that frequently too little consideration is given, both at the time of routine medical inspection and on reference to the consultant, to the child's full medical history and to the season of the year, and that an increasing number of tonsillectomies are performed unnecessarily or at an unsuitable time.

Parents are notified by the school authorities of the time of the inspection, and should be encouraged to attend. Although the presence of parents tends to slow down the session, it is a great advantage if they can be present to supplement the medical history, receive advice direct from the medical officer, and have explained to them the need for any treatment that may be advised.

Since the successful working of the school medical service depends not only on obtaining the confidence and co-operation of the parents, but also on the closest co-operation between medical officers, school nurses, care committee, and teachers, it is essential that the medical officer should be accessible to the head teacher and available for special inspections of children referred by the head teacher or nurse.

Whilst the obligatory provisions of the original Act only covered the inspection of children in public elementary schools, the scope of the service was subsequently extended to children attending state-aided secondary schools; up to the time of passing of the 1944 Act, however, the requirements with regard to inspection of secondary school children were ill-defined, and the service was not generally considered adequate. In the case of both elementary and secondary school examinations, insufficient emphasis was laid on a final medical inspection shortly before the child left school, since this examination should form the basis of directing defective children into suitable trades. With the raising of the school-leaving age and the inclusion of all children within a national health service, a drastic revision of the scheme of routine inspections is inevitable.

Dental inspections were instituted later than medical inspections, and though their importance was soon realized, the school dental service, even by 1939, was not sufficiently large to ensure an annual dental inspection for all school-children. There has been some difference of opinion as to whether the first inspection should be held when children first enter school at five years. or when they have reached six to seven years, *i.e.*, when the permanent teeth are beginning to erupt. With the expansion of the service, it is probable that a first inspection at five years followed by an annual inspection throughout the school life of the child will be made.

As in the case of medical inspections, dental inspections are carried out at a central school dental clinic or health centre or in school premises. In sparsely populated country districts the use of a travelling dental caravan has certain advantages, since in small schools it is generally necessary to combine an inspection with treatment. (Disadvantages of a caravan are that it is too small, provides no waiting-room, is difficult to heat adequately in winter, and has no running water.)

School Treatment Centres and Dental Clinics

Although established for the treatment of ‘ minor ’ ailments only, the school treatment centres have been responsible for the prevention of an incalculable amount of minor ill-health and absence from school. To take a single example, there were in 1910, when the first treatment centre was opened, several thousand children among the school population suffering from ringworm of the scalp; in 1920 the number treated was 1,840; in 1934 the number had fallen to 195, and by 1939 the condition had become a rare disease. A great reduction had also been effected in the incidence of scabies, impetigo, and pediculosis, and though the recent war conditions (evacuation, overcrowding, and sleeping in air-raid shelters) resulted in an increase in these three complaints, the school treatment centres have served to keep their spread within bounds.

The treatments are usually carried out by a school nurse under the direction of local medical practitioners. Up to the present time, parents who can afford to do so might be required to contribute toward the cost of treatment. Under the 1944 Act, however, children are now entitled to treatment free of charge.

Dental treatment is carried out either in school dental clinics by dentists of the school dental service, or by arrangement with independent dental clinics. The work is almost entirely confined to extractions and fillings, there being at present very few facilities for orthodontic treatment except in some half dozen dental centres. There is still, unfortunately, a considerable hiatus between the number of children recommended for dental treatment and the number who actually attend.

Special Schools

From the earliest days of compulsory education it had been realized that it was impossible to educate blind, deaf, mentally defective and epileptic children in normal elementary schools. Since that time, local authorities have been required to establish special schools suited to physically or mentally defective children. Although in some municipal areas the provision of such schools has been highly organized, and transport difficulties overcome by delivering the children to and from their homes by ambulance, the accommodation in such schools in 1939 was still inadequate, and in many country districts unobtainable. The number of special schools was, however, being steadily increased, and whereas in 1910 there had been 308 schools with accommodation for 22,000, in 1935 the number of schools was 610 and the number of children accommodated 57,852. The provision of educational facilities in long-stay hospitals (*e.g.*, for heart and orthopædic cases) was also being increased.

In addition to the special schools for blind, deaf, mentally defective and crippled children, the provision of open air schools has been found of great benefit for children suffering from bronchiectasis and other chronic pulmonary conditions, and the ill-defined group of sub-normal or 'debilitated' children whose condition may be due to poverty, bad home conditions, anxiety, recurrent infections, or congenital inferiority. The first open air school was opened at Bostall Woods in 1907; in 1939 there were 15 open air schools in the L.C.C. area, whilst over 6,000 children were attending open-air classes in the London parks. School camps have also been of such value in improving the health of the school-child that they require mention. The Education Act of 1921 empowered the local authorities to aid the provision and maintenance of school and holiday camps, either set up by the education authorities themselves or by voluntary bodies, and the Physical Training and Recreation Act (1937) extended these powers. The 1907 Act had previously made some provision for holiday camps, which had been taken advantage of by a few local authorities, but the 1918 and 1921 Acts went considerably further, and recognized the value of camps held during the school term in 'supplementing and reinforcing the instruction' in addition to 'the social and physical training.' In 1937 there were at least 41 local education authorities who had sent children to holiday camps, and 56 to camp schools during term time.

Care Committees

During the latter part of the nineteenth century, various bodies of voluntary workers had undertaken welfare work amongst school-children. The importance of their work was recognized in the 1907 Education Act, when it was made obligatory for local education authorities to set up care committees with clearly defined functions. This involved an important principle, namely, the support of voluntary work by public funds. The care committees have remained essentially voluntary and self-governing bodies, appointing their own chairmen and honorary secretaries, though some authorities, *e.g.*, the London County Council, have appointed salaried organizers in addition; each London borough has a Local Association of Care Committees, composed of representatives of the care committees, teachers, and members appointed directly by the L.C.C. The professionally-trained staff are responsible for recruiting and training voluntary workers, and for co-ordinating their activities.

Responsibilities. The period of evacuation of school-children during the war of 1939–45 greatly increased the responsibilities of the local care committees, and in the case of children boarded out in foster homes it appears that these were not always appreciated. In normal times, the principal duties of the care committees fall under three categories :—

(1) To see that recommendations made by the school medical

officer with regard to further investigation or treatment are implemented.

(2) To see that children requiring extra nourishment receive it; this may be effected through the home or by means of school meals. It was previously necessary for the care committee to discriminate between necessitous and non-necessitous cases, but the 1944 Education Act has radically changed the basis on which school meals can be provided (see below).

(3) To help children leaving school to find suitable employment, and to make certain that they are informed of the local facilities available for further education and recreation.

The scope of care committee work is, however, much wider than might at first appear from the above, since a worker who has established friendly relations with the parents may be consulted on an almost infinite variety of individual problems relating to the health and welfare of children. The Children's Act of 1908 made it possible to deal with cases of cruelty and neglect, and here again the care committee worker is required to investigate the circumstances in the first instance. If necessary the assistance of the National Society for the Prevention of Cruelty to Children is enlisted.

Where convalescence or a country holiday is considered necessary, the care committee will make the necessary arrangements either with camps or residential homes under the local authorities or with appropriate voluntary organizations such as The Children's Country Holiday Fund, The Invalid Children's Aid Association, The Shaftesbury Society or the Save the Children Fund. This frequently involves more than simply finding a vacancy, since suitable clothing may have to be provided.

The follow-up of cases recommended for medical treatment is an important part of the care committee work. Often the parents have to have painstakingly explained to them the need for treatment, and be persuaded to allow the child to receive it. To take a single example, the provision of spectacles may prove only a first step; the co-operation of parents, school teacher and child may have to be enlisted before they are actually worn. The frequent difficulties in respect of dental treatment have already been referred to. In all matters of health the trained care committee worker can carry out invaluable work in spreading a knowledge of personal child health and hygiene.

The early recognition and investigation of behaviour problems is as important as the more material side of the care committee work. These will sometimes be found due to maladjustment in the home or school, which can be dealt with by tactful handling;

in other cases it may be necessary to seek the aid of a child guidance clinic. By such means it is frequently possible to avoid children coming into the 'delinquent' group and appearing before the children's courts.

Care of the child on leaving school presents an immense problem which it is hoped that the raising of the school-leaving age, and increased facilities for technical education, may go a long way to solve. Up to the present time it has been only too common to find intelligent children of fourteen stepping straight into 'dead-end' employment (*e.g.*, as errand boy) in which they receive no further education or means of learning a trade. Whilst direction to employment will obviously depend to a large extent on economic conditions, it has been a function of the care committee to see that children leaving school not only retain the benefits of the education they have received but are encouraged to continue their education by evening classes or apprenticeship in suitable trades. In this the care committee should work in close association with the Juvenile Employment Bureau, and it is probable that in future these responsibilities will largely be taken over by the Employment Bureau.

Provision of School Meals

The early history of school meals has already been mentioned; they were originally planned for those children who were so ill-nourished as to be unable to take full advantage of the education provided. Free meals were subsequently made available to necessitous cases, after investigation of the home circumstances by the care committee. This principle, *i.e.*, qualifying by economic necessity, received a rude set-back by a decision (Circular 1437) reached by the Board of Education in 1934, when it was laid down that children could only receive free meals if recommended for them on medical grounds in addition to being in necessitous circumstances. The decision was hotly contested, it being pointed out that if this principle were rigidly enforced, it would mean that a child so poor and ill-nourished as to qualify for free meals on medical grounds would be deprived of them as soon as he had benefited, and would have to undergo a further period of malnutrition of sufficient duration for stigmata to reappear before he could re-qualify. Non-necessitous cases, however, could receive school meals on payment. Since, however, the standards as to what constitutes 'sub-normal nutrition' are ill-defined, it is probable that the Board's decision was rendered less inequitable in practice than in theory (Wilson, 1938).

During the war of 1939–45, the provision of school meals was one of the public services which made notable advances. Not only was it in the interests of the national economy to encourage communal feeding (both from the point of view of food and fuel), but transport difficulties in rural areas often made it impossible for children at central schools to return home for middle-day meals. The results achieved in spite of conditions which were, to express it mildly, unpromising, were really remarkable. Most of the older schools had no suitable dining-room or kitchen accommodation, and this had to be improvised, often involving a second sitting for meals. Crockery, utensils, and cleaning materials were in short supply and, above all, shortage of staff threw an even greater burden on the already overworked teachers. That this burden was willingly shouldered, both by teachers and voluntary workers, is universally agreed, and it is largely due to their efforts that a considerable proportion of the school population was actually better nourished at the end of the war than in peace-time. In many rural areas, great enterprise was shown in the provision of school meals, both by the school authorities and district organizers. In one large central school visited in an agricultural district, all the vegetables were grown by the boys who attended classes in scientific agriculture as part of their curriculum, much of the cooking and serving carried out by the older girls, and the school was not only able to feed its own scholars but several hundred boys in a neighbouring grammar school.

In addition to school milk (consisting of a third of a pint of fresh milk, if the supply is satisfactory, or condensed or dried milk made up for drinking if it is not), for which 1*d*. is charged, school meals consist of a cooked, two-course, middle-day dinner, the charge in non-necessitous cases usually varying between 4*d*. and 7*d*. In some cases, breakfasts and teas are also provided. The 1944 Act has laid down that every local education authority must establish a school meals service and employ an organizer. On all school days, substantial mid-day meals and not less than one-third of a pint of milk per pupil must be provided in all maintained schools. Other meals in addition may be provided on school days, and milk and meals on any other days. Charges may be wholly or partially remitted in cases of financial necessity. (The question of payment in non-necessitous cases is still under consideration.)

Health Education in Schools

Although not strictly a function of the school medical service, this important aspect of child health may be mentioned here.

It is the policy of the Ministry of Education to encourage the inclusion of both health education and domestic science in the school curriculum, and an advisory brochure, 'Suggestions on Health Education,' was published for the guidance of teachers in 1928 and has subsequently been revised. Whilst not laying down any set form of instruction, it covers the principles of personal health and hygiene, and emphasizes the importance of all teachers not only having a personal knowledge of these principles, but of passing them on to the children and making their practical application a matter of general acceptance in home and school life.

Sex Education. It is significant that in the 1939 edition of 'Suggestions on Health Education,' which covers a wide range of physiology and such varied subjects as infant welfare, antisepsis, and malaria control, the subject of sex is not even mentioned. During the recent war, the serious dangers of neglecting this aspect of education were officially recognized, and the Board (1943) published an educational pamphlet entitled 'Sex Education in Schools and Youth Organisations.' This cannot be described as a very inspiring document. Apart from a few unimpeachable general principles with regard to answering children's questions and an assurance of warm support to those undertaking sex education, no policy is indicated and no syllabus given. The pamphlet does, however, summarize what has been done in schools throughout the country. In many, and probably, the majority, the answer is nothing. In others the matter is referred to the parents and allowed to rest. The great majority of schools which have tackled the problem seriously have met every encouragement from the parents ; it is interesting to find that instruction is given in approximately three times as many girls' schools as boys'.

In most instances, the best approach has been found to be through biology classes, and by first introducing the subject at an early age (eleven or before) ; this has the great advantage of establishing a more or less objective approach, so that questions can be asked freely, in preference to first broaching the subject in the self-conscious atmosphere of puberty. With the onset of puberty, however, personal problems will arise, such as personal hygiene and menstruation, which should be dealt with more fully than in the earlier age group. Unfortunately, chronological age (and position in school) does not correspond with a uniform stage of physical and emotional maturity, and since it is important that more detailed sex education should be given to children of approximately the same stage of maturity, the groups should be selected as far as possible on this basis rather than on chronological age.

With the raising of the school-leaving age, the advisability of instruction with regard to the dangers of venereal disease arises in the case of school-leavers. This is a subject on which the advice and help of the school medical officer may well be sought, and one which, needless to say, requires extremely tactful handling in addressing an audience at a particularly impressionable age. The best approach is probably through a general discussion of infection, immunity, prophylaxis, and public health, so that a proper sense of proportion is kept with regard to healthy living and disease in general. When such talks are given either by a doctor or science teacher, the same objective treatment should be given to sex as to the rest of the subject, since a mixture of scientific fact and moral judgment is only likely to confuse the audience and defeat its own object.

Domestic Science and Infant Welfare. Most education authorities have attached increasing importance to the teaching of domestic science and housewifery to older girls, and in many instances instruction is given in infant welfare and the care of young children. The value of this early training for motherhood hardly needs stressing. Some schools have carried out most successful experiments in having a model flat attached to the school, where older girls take turns to stay in residence and learn house management under a resident mistress. The extension of school canteens has also given practical experience in cooking and catering.

Games and Physical Training

The advice of the school medical officer is frequently required with regard to exercise and particular activities, such as swimming, in individual cases, and also as to physical training generally in the school curriculum. Organized games, physical training, and more recently swimming have been an integral part of the English educational system for so long that their value is universally recognized, and whilst there has been some reaction against the fetish of games in Public and independent Schools, there has been a steady increase in the facilities for teaching games and swimming in state-aided schools throughout the country.

It may be necessary for the school medical officer to satisfy himself with regard to the cleanliness of swimming baths and take steps to prevent the spread of epidermophytosis and plantar warts in bath houses; to make sure that tinea and impetigo are not being spread by the indiscriminate use of towels and changing-clothes; and to exclude from swimming children with running ears or other infective discharges. When the school has a gymnasium, he should be satisfied that it is kept clean and properly ventilated. Attention should be paid to under-developed and weakly children who are liable to be over exercised by a too enthusiastic instructor.

It is equally important that the doctor should not be too anxious to exclude children from physical activities unless he is certain that their condition warrants it. For example, a child who has had growing pains and has a systolic murmur may be turned into a real invalid, with the classical picture of effort syndrome, by a doctor who has 'played for safety' by excluding him from all activity in the absence of an organic heart lesion.

Even in cases where a physical disability is present, the aim should be to encourage the full range of activity which the child can carry out without suffering further injury. This is well seen in certain cases of well-compensated heart disease, where graduated activity under careful supervision will give a better functional result than complete rest.

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CHAPTER XVI

NURSERIES AND NURSERY SCHOOLS

For convenience, nurseries may be divided into those provided for newborn and premature infants, and those for infants up to five years (*i.e.*, school age). The term ' crèche ' is sometimes used for day nurseries. An administrative and educational distinction has been drawn between ' nurseries ' for older infants and ' nursery schools,' and has resulted in one coming under the supervision of the Ministry of Health and one under that of the Ministry of Education. A more fundamental distinction is between day and residential nurseries, since the problems of staffing and accommodation are different in the two cases, and the infant who is in daily contact with its own parents will have a different social and emotional background from the infant who develops solely as a member of a nursery group.

Nurseries for older infants have come in for a great deal of criticism on two grounds (1) the spread of infection, and (2) the charge that they encourage women to avoid the responsibility of looking after their own children. The spread of infection, particularly gastro-enteritis and dysentery amongst infants under two years of age, is a very real one, and can only be avoided by adequate staffing, trained supervision, and the provision of proper accommodation. With regard to the second charge, forced evacuation, the wholesale destruction of private dwellings, and the mobilization of women during the war years, created artificial social conditions in which nurseries proved of inestimable value in meeting the emergency. It is now generally recognized that many of the war nurseries will continue to serve a useful purpose for come considerable time to come, and that there are still many parents who, through no fault of their own, cannot undertake the full responsibility and care of their children. Apart also from necessity, it has become obvious that a really well-run day nursery or nursery school can contribute to the infant's social development, and render the transition to compulsory school attendance very much easier when school age is reached.

Newborn Nurseries

Since newborn nurseries have none of the social advantages of those for older infants, and carry the same risk of infection, it might be said that the best means of preventing cross-infection was by not putting newborn infants together in one room. The best place for a newborn infant is certainly with the mother in a separate room or cubicle, since this gives the mother an opportunity of getting to know her infant before she has to take full responsibility for him, and reduces the amount of handling and carrying by different people to a minimum. In most maternity units, however, where the mothers are nursed in open wards, and individual washing facilities are inadequate, it is usually impracticable for the infants to be with their mothers throughout the twenty-four hours, nor does the condition of the mother always make it desirable that they should be. The provision of a newborn nursery, however, should never be made the excuse for entirely segregating the infants from their mothers except at feeding time, and the mother should always be given full opportunity for washing, changing, and getting to know the needs of her infant before she goes home.

The newborn nursery should be a small unit, and contain not more than eight to twelve babies, although this number is commonly exceeded. For this number there should be at least four bath-sinks, placed at a convenient level for washing the baby when the mother or nurse is seated; the sinks should be fitted with taps that can be regulated by the elbow or foot, in order to avoid handling taps when the hands are sterile. The washing utensils of each baby must be kept separate. There should be no hangings or fittings which cannot be easily washed, and the room should be designed to avoid dust-traps, *e.g.*, ledges and tops of cupboards.

Ventilation has been a matter of much discussion, and whilst air-conditioning has its advocates, it is generally felt that if (as not infrequently happens) anything goes wrong with the mechanism of the plant, the disadvantages of this system so much outweigh the advantages that it is best avoided. Outside ventilation by windows designed to allow the exit of used air above, and the inlet of fresh air in such a manner that no baby is in a direct draught, is quite adequate for ordinary purposes. The nursery should be kept at a temperature of approximately 70° F. (21° C.) and regular temperature readings should be made and charted. The regulation of humidity is of less importance than in the case of premature infants (see below), but it is advisable to have a wet and dry bulb thermometer in the nursery, so that major changes in humidity can be avoided. If necessary, the windows and doors should be fly-proofed.

The rectal temperature of infants should be taken and charted four-hourly, a separate thermometer being kept for each infant and kept sterile between use. The temperature will not only help in recognizing the presence of infection or dehydration, but sub-normal temperature readings will show that infants have been allowed to get too cold.

No visitors should be allowed in the newborn nursery, and all attendants should be instructed in the prevention of infection. A gown should be worn when washing or changing infants, but it should be remembered that a gown is only a protection if it is clean ; a dirty gown is just as likely to spread infection as a uniform. No attendant or mother with an upper respiratory or other infection should be allowed in the nursery. The routine use of masks is advisable only if it is carried out efficiently ; otherwise it is worse than useless.

Isolation facilities are essential. No infant with an infection or unexplained temperature should be kept in a nursery with healthy infants. The prompt removal of any infant suffering from diarrhœa, thrush, pemphigus, or other infection will be the surest means of limiting spread. Unless scrupulous care is taken with regard to the cleanliness of feeding utensils and removal of dust by wet-dusting and cleaning, it will be found that thrush may very easily become epidemic and have serious consequences, whilst skin sepsis, once it has occurred in a nursery, may prove extremely difficult to eradicate. Epidemic diarrhœa when it occurs amongst newborn infants is likely to cause a high mortality ; thorough washing of the hands before touching any infant is an important precaution in its prevention. Hand-towels for the attendants must be kept dry and clean, since not only can infection be conveyed by the towels themselves, but continual wiping of the hands on damp towels is likely to result in chapping and abrasions, and consequent spread of infection by the hands.

It is usual for the infants' cots to be so designed that they will fit on to metal racks or stands ; this is a considerable convenience, but should not be used as a means of overcrowding. Babies should as far as possible be transported to and from the ward in their cots, and the carrying of an armful of babies should be strictly forbidden.

Finally, a point of considerable practical importance is that all infants entering a newborn nursery should have an identity-label attached immediately after birth. The necessity for this in a large and busy unit is obvious.

Premature Nurseries. Since the premature baby requires special care, and will need to be kept at a higher temperature than the full-term baby, it is advisable in large maternity units where these infants cannot be nursed in separate rooms to have special premature nurseries provided. Where large numbers are dealt with, the smaller infants, *i.e.*, those weighing less than about 4½ lb. (2,050 g.) should be separated from the larger prematures (4½ to 5½ lb., 2,500 g.).

The optimum temperature of the nursery for the smaller infants has been found to be approximately 85° F. (30° C.) and for the larger infants 75° F. (24° C.); if it is not practicable to keep the nurseries at these temperatures, individual cot-warming is almost equally satisfactory, though rather more laborious when the open type of metal cot is used. Closed incubator-cots, serving also as oxygen-beds, can be thermostatically controlled and are convenient but expensive. It will be found easier to maintain an even temperature if the nursery has been constructed with an ante-room, so that less cold air enters each time the door is opened.

Since the heat-regulating mechanism of the premature is poorly developed, the humidity of the nursery is of considerable importance. Blackfan and Yaglou (1933), who investigated the effect of temperature and humidity in air-conditioned nurseries on the weight-gain, growth, and morbidity of prematures, recommended an approximate humidity of 65 per cent. for temperatures ranging from 75° to 100° F. (24° to 38° C.), but found that whereas infants weighing less than 4½ lb. (2,050 g.) on admission gained weight more rapidly when the humidity was high, the reverse was true of infants weighing more than 4½ lb. A wet and dry bulb thermometer should be kept in the nursery, and an approximate adjustment of humidity effected. This may be done by a variety of simple means, *e.g.*, a damp sheet placed over a radiator, a steam kettle, or a constant drip of water on to strips of flannel placed in front of a radiator or air-inlet.

It is even more important to avoid overcrowding prematures than full-term infants. Crosse (1945) recommended 50 sq. feet of floor space for each cot. Each cot should be on a separate stand, and be provided with a locker containing the toilet articles, thermometer, etc., belonging to the particular infant.

Skilled nursing in the case of prematures is essential, and a specially-trained permanent staff should be allocated to the nursery. Each infant should be on individual barrier precautions, and owing to the length of time taken over feeding it will usually be found that a staff of one nurse to four of the smaller prematures is a minimum on any shift. Strict attention to gown-and-mask technique, hand-washing, etc., must be observed (Med. Res.

Council, 1944). It is particularly important that masks should be impervious or changed sufficiently frequently to prevent their becoming saturated. Visitors must be entirely excluded and the number of persons entering the nursery reduced to a minimum.

Day and Residential Nurseries

The modern crèche or day nursery appears to have originated in France after the Napoleonic Wars, when large numbers of women entered industrial or other employment (Nathan, 1943). During the latter part of the nineteenth century the idea of the day nursery was widely adopted in France, and in 1869 the Societé des Crèches was recognized by the French Government. Often such crèches were grossly over-crowded, and subject to no trained or central supervision, since they were at first established primarily for the benefit of the mother rather than the welfare of the child. In England, a day nursery was established in London in 1860, but it was not until the National Society of Day Nurseries (now the National Society of Children's Nurseries) was formed in 1906 that the modern conception of a day nursery as an institution which should be of benefit to both mother and child, gained any general acceptance. During the succeeding forty years, the history of the movement is another excellent example of the way in which a public need has been realized by a small group of enlightened voluntary workers, official recognition gradually gained, and an organization built up which was able, with official support, to undertake enormous responsibilities during two periods of national emergency. As already indicated, the work was not allowed to proceed without considerable opposition; some of this was helpful, since it stressed the need for proper staffing and medical supervision if infection was to be avoided, whilst much of it was ill-informed and based on a misconception of the nursery movement. As the Archbishop of Canterbury succinctly put it, when speaking of children's nurseries: 'I find that people who object to them, and prattle most about interference with family life, generally have a nursery in some other part of the house to which they can banish their children when they feel like it. Don't forget that family life is one of those things which flourish best when not subject to an unendurable strain.'

During the war of 1914–18, the recruitment of women into industry gave fresh impetus to the movement, and many day nurseries were set up in munition areas. Official recognition of their peace-time value followed when the Maternity and Child Welfare Act (1918) was passed, and local authorities were empowered to set up day nurseries for which they could receive official grants. A second and much greater impetus was given with the outbreak of hostilities in 1939; wholesale evacuation and employment of female labour to an extent never before contemplated necessitated the setting-up of both day and residential nurseries on a national scale. With the increasing severity of aerial bombardment, the need for war-time nurseries grew rapidly from the middle of 1941. In December of that year a joint circular was issued by the Ministry of Health and Board of Education impressing on local authorities the necessity of providing nurseries for the children of women workers. In 1942 there were 675 whole-time and 151 part-time nurseries opened, and in June, 1944, the number of full-time nurseries had increased to 1,446; these, and 114 part-time nurseries, provided accommodation for over 71,000 children. The war-time nurseries have been under the control of the Ministry of Health, which has provided a 100 per cent. grant to its local Public Health Authorities for each nursery established. The condition of entry to a war-time nursery was the employment of the mother in some form of war-work. In spite of the very great difficulties under which this expansion of the nursery movement was carried out, the most serious of which were shortage of staff, building materials, labour, and accommodation, there can be no question that the war-time nurseries have proved an outstanding success. The difficulties in the establishment of residential nurseries were naturally greater than in the case of day nurseries, since in many instances they had to be housed in the premises of nursery schools or large country houses which were not designed for the purpose and could not be readily adapted; shortage of running water, sluices, washing and toilet facilities, and adequate isolation and kitchen accommodation were an inevitable danger, and in some instances led to outbreaks of infantile diarrhœa or other infection. On the whole, however, the health of children in war nurseries was good, and the incidence of infection considerably lower than might have been expected.

Following the cessation of hostilities, the National Society of Children's Nurseries (1945) issued an admirable Memorandum for the Royal Commission on Population, in which the case for children's nurseries during peace-time is clearly put. It is pointed out that there will, at least for some long period, be many mothers of young children who for one reason or another are forced to work; the case of the professional woman is considered; and the need for temporary nursery facilities in cases of maternal illness or pregnancy is emphasized. Nathan (1943) had already urged the need of the working-class mother for a weekly day's holiday, in common with other workers, and in a 'Four-years Plan' for children's nurseries had shown how this, and other aims, might be accomplished. It was recommended that the provision of nurseries should form an essential part of new housing schemes, and that where possible nurseries should be one-storey buildings in blocks, providing for forty to sixty children (an economical and manageable unit). Each nursery block should be sub-divided into sections of twenty in order to lessen the risk of cross-infection, and should be provided with playground and garden. It was estimated that five-day-a-week nursery provision could be made for approximately 10 per cent. of the three million children in the country aged nil to five, over a period of four years. It was pointed out that whilst nursery schools will provide for the needs of a large group of mothers, the times of opening of nursery schools do not cover the working hours of most mothers in employment, and that such nursery schools only accept children aged two to five years.

In December, 1945, the Ministries of Health and Education issued a joint circular to local authorities, recognizing the continued necessity for nursery accommodation, and calling for a review of requirements, based on the suggested combination of use of nursery schools, and classes, day nurseries, daily guardians, home 'sitters-in,' and the use of welfare centres as crèches for two or three afternoons a week. It is therefore clear that children's nurseries have not only proved their value during the war, but now form an essential item in post-war planning. It has never been suggested that they should attempt to replace the family or perpetuate conditions which make it necessary for mothers with children under two to go out to work. But there is ample proof that they not only meet an urgent need in the present transition from war to peace-time labour and housing conditions, but as an integral part of the permanent social services can and should serve to make child-bearing and rearing a more tolerable proposition for the working-class mother.

Staff and Training. The various organizations and training colleges concerned with children's nurseries have all recognized certain guiding principles with regard to staffing.

(1) The choice of a suitable matron is essential. The National Society of Children's Nurseries have adopted the principle that the matron should have a general or sick children's nursing training, preferably with public health and/or nursery training in

addition; courses in nursery training are organized for student matrons. Whilst the necessity for nursing training (as distinct from nursery training) is not universally accepted, it has obvious advantages where the health of the children and early detection and isolation of cases of infection are of such outstanding importance. The matron should be supported by at least one other trained deputy.

(2) A medical officer, who is readily accessible to the nursery, should be appointed, and regular medical inspection regarded as obligatory.

(3) The staff must be adequate in number, the proportion of staff to children being higher when infants under two are included in the nursery. This proportion will vary between one to twelve and one to five children. In residential nurseries, the staff will have to be two to three times as large as in the case of day nurseries, to allow for three eight-hour shifts.

(4) The standard of selection, training, and consequently status of nursery-nurses is of the first importance in securing the healthy development and welfare of the children, and in attracting the right type of women into the profession of nursery-nurse. Until recently, the N.S.C.N. (through the medium of the Royal Sanitary Institute), the Norland Institute, the Waifs and Strays Society, and other organizations and training colleges, have granted separate diplomas to trained nursery-nurses. It is now proposed to unify the scheme of training and examination, the latter being carried out by the Royal Sanitary Institute.

Since it is possible for girls to start nursery-training at an earlier age than sick nursing training, every encouragement should be given them to follow their nursery training by general or sick children's nursing training, and so qualify for higher appointments.

The initial and regular medical inspection of trainees is essential, and routine chest radiography on selection highly desirable, since the dangers involved in introducing anyone with a tuberculous lesion into a children's nursery are very great.

(5) A nursery-teacher should be included in the staff, and nursery classes form part of the nursery routine.

Nursery Schools

The Nursery School or Kindergarten has not developed in the same manner or to the same extent in Britain as in many continental countries, the British system of infant education being in many ways unique. The historical explanation for this is largely attributable to the industrial revolution in the early nineteenth century, with its demands for child labour and extensive employment in industry. Since at this time many children began work at the age of ten, there was constant pressure for education to begin early, and when compulsory education was introduced in 1870, the age of compulsory attendance was fixed at five years instead of at six or seven (the usual age in most other European countries). In fact, when the Bill was originally debated in the Lords, Lord Shaftesbury, one of the greatest champions of the poor in English history, had advocated that the age of attendance should be four years rather than five.

Although the original necessity for infant education was a bad one, and was largely eliminated by successive Acts of Parliament for the protection and limitation of child labour, it resulted in a system in which infant departments of elementary schools (for children aged five to seven) became an integral part of state education, and was followed by the grafting on of nursery classes (for infants aged three to five) to infant departments, rather than by the separate establishment of nursery schools. At its worst, the inclusion of large numbers of infants under five in the elementary schools was a drag on the education of the older children, and a menace to both the health and development of the younger infants. Thus in 1900–01 there were 615,607 infants aged three to five attending school in England and Wales, *i.e.*, 43·1 per cent. of the total number of infants of this age in the country; classes were grossly overcrowded, accommodation unsuitable, and there was at this time little general application of methods appropriate for infants. At its best, when separate accommodation and educational methods are employed on kindergarten lines, the system has considerable advantages, both from the economic point of view and in making the transition to the elementary school an easy one. Thus the overhead costs per head are considerably less in nursery classes than in separate nursery schools (Miller, 1944), but on the other hand the nursery school or class must be situated within easy reach of the homes, and local conditions in a particular area may make the establishment of separate nursery schools the method of choice. It is now generally agreed that infants under five can and do benefit by nursery education on modern lines, and that a more comprehensive system of medical supervision than is at present otherwise provided for infants between three (or two in the case of separate schools) and five is highly desirable. This is reflected in the provisions of the 1944 Education Act (see Chapter XVII) and recent joint recommendations of the Ministries of Health and Education to local authorities with regard to the provision of nursery classes and schools.

An excellent historical summary of the growth of the nursery school is given in the Board of Education's report on 'Infant and Nursery Schools' (1933), to which frequent reference will be made. The prototype of the nursery school as a separate entity is to be found in the Dame Schools, which flourished in England during the eighteenth and early nineteenth century; these were usually run by indigent and often extremely ignorant old women in their own homes for private profit. Whilst there were undoubtedly exceptions, the Dame Schools as a whole acted as a drag on progress in infant education until the passing of the Education Acts of 1870 and 1880. The first nursery school in Britain to foreshadow modern developments was that founded by Robert Owen in 1816 in New Lanark. Owen realized that out-door activity and play, and opportunity to develop the powers of observation, were essential in infant education, and reacted against the older methods of teaching by rote and instruction in the three R's before the age of five. The example of Owen's New Institution was followed in 1818 by the establishment of an infant school in Westminster under the charge of James Buchanan, a disciple of Owen's, and by the opening of a second infant school in 1820 in Spitalfields under the charge of Samuel Wilderspin. Wilderspin was less enlightened than Owen, but did much to popularize the idea of infant education, and was partly responsible for the foundation of the Infant School Society in 1824. He was followed by David Stow, who established a model infant school in Glasgow in 1828, in which he developed the educational principles of Owen, but in addition laid emphasis on religious instruction. There was at that time little organized training of teachers for infant schools, and this was first seriously undertaken by the Home and Colonial Institution (later Infant School Society) in 1836. From this time onward, the infant school movement developed rapidly in England and Scotland, though until 1854, when the work of Froebel was introduced to the English public by an educational exhibition and lectures, the growth of the infant school appears to have been largely independent of continental influence. (Some English educators, however, were previously influenced by Pestalozzi.)

In Europe the first nursery school had been founded in 1769 by J. F. Oberlin, of Waldbach, but it was undoubtedly Friedrich Froebel, who opened his famous Kindergarten in Thuringia in 1837, who was most responsible for the development of infant education in its modern form. He regarded the kindergarten as a supplement to home training and in no sense a substitute, and with this always in mind attempted to work out an educational system which should serve to encourage the child to think and observe for itself rather than be spoon-fed with information by a teacher. After their initial introduction into England, Froebel's ideas were widely popularized in this country by Charles Dickens, whose fame as a novelist gave him great weight as a reformer. The Home and Colonial Infant School Society adopted the Froebel system in 1860, and the Froebel Society was founded in 1874. Kindergarten training centres were established at this time.

Of more recent developments the nursery school founded in Deptford in 1911 by Rachel and Margaret McMillan requires particular mention, as it has served as a model in Great Britain and elsewhere since that date. The school embodies certain principles of construction which, whilst not always easily attainable in a built-up area, are fundamental in the conception of a large nursery school. Built on the ‘village’ plan in a large garden-playground, the school consists of a number of self-contained units or shelters, each under the charge of a different teacher and accommodating thirty-five to forty infants; each has separate washing, drying, and lavatory facilities, and provision for afternoon sleep. The infants are provided with three meals during the day and as much time as practicable is spent out of doors. By the division of the school into self-contained units and insistence on fresh-air and adequate floor space, the risks of cross-infection are limited. A training college for teachers and a treatment centre are run in association with the school. Margaret McMillan was not only actively associated with the development of this school until her death in 1931, but was first president of the Nursery School Association of Great Britain which was founded in 1920, and has done much to develop the nursery school movement throughout the country.

Shortly after the opening of the Rachel McMillan School, the work of Dottoressa Montessori became generally available to English readers (George, 1912), and has had a profound influence, particularly on the equipment, of nursery schools. Apart from the introduction of chairs, tables, basins, etc., of appropriate size for infants in place of the fixed backless desks and pens which had previously been a feature of many infant schools, Dr. Montessori was responsible for the design of a variety of nursery apparatus suitable for the development of dexterity and observation of infants of different ages. She stressed the importance of individual occupation of the infants and a minimum of interference by the teacher.

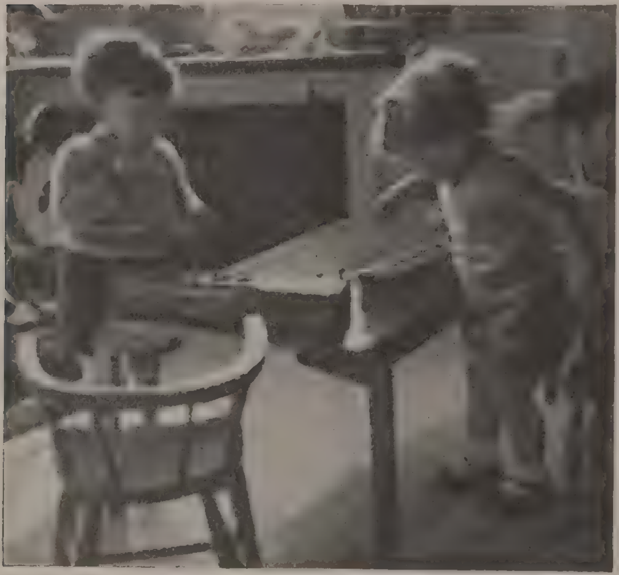

FIG. 45. Nursery furniture should be an appropriate size, and play material suitable for the age and intelligence of the children.

FIG. 46. Building-blocks serve to develop dexterity.

FIG. 47 and 48. Natural obstacles in the nursery garden will often give as much satisfaction as more elaborate equipment. Ski-suits make suitable outdoor clothing in winter.

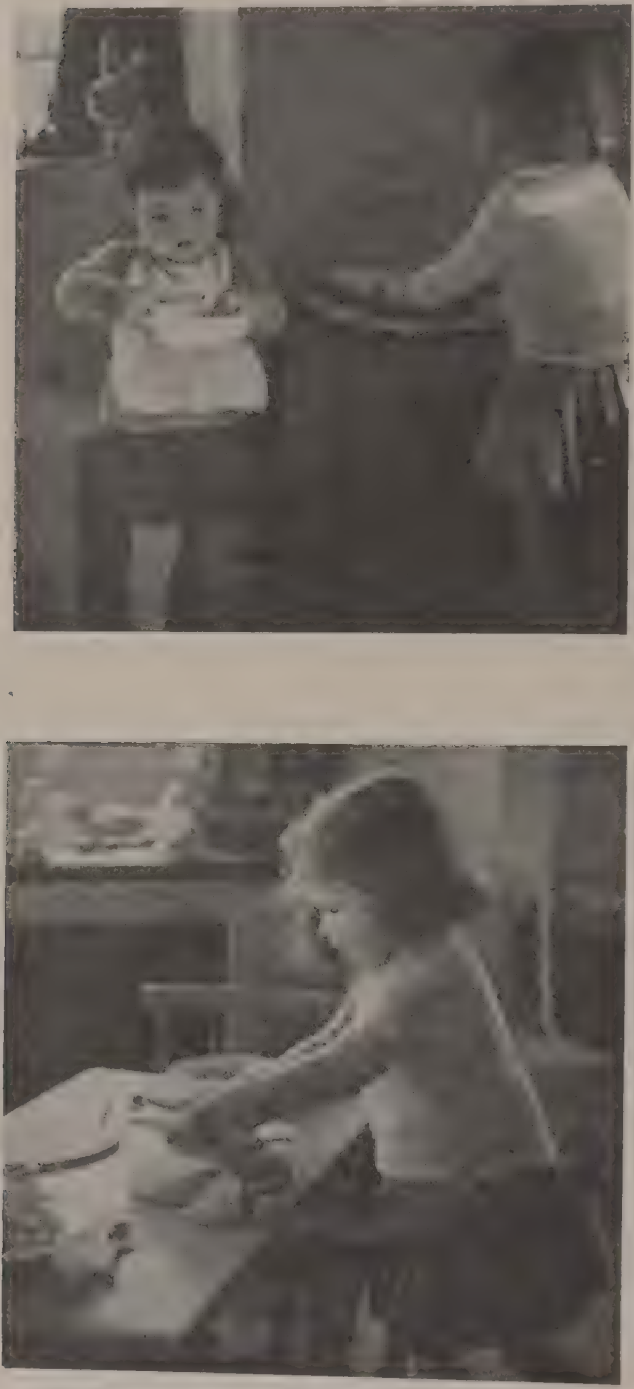

Fig. 49 and 50. Self-service in a residential nursery.

Official recognition of the value of nursery schools was accorded in the provisions of the Education Act of 1918, when local education authorities were empowered to provide or subsidize such schools and nursery classes for infants aged two to five years, and attend to the ' health, nourishment and physical welfare ' of infants attending them. The Education Act of 1944 went considerably further, and whilst there is no compulsion for infants under five to attend nursery schools or classes, the local authorities have been urged to provide facilities where necessary or desirable. It cannot be said that the minimum standards laid down for staffing and accommodation are yet adequate, but in the present interim period of shortage of trained teachers, ' helps,' and building facilities, it is at least recognized that infancy must be served at least as liberally as youth.

R. W. B. Ellis.

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CHAPTER XVII

THE ENGLISH EDUCATIONAL SYSTEM

The Government White Paper on Educational Reconstruction issued in 1943 to indicate the lines upon which comprehensive reform was being contemplated and to stimulate public debate preparatory to the introduction of a Bill, opens with these words :

> ' The Government's purpose in putting forward the reforms described in this paper is to secure for children a happier childhood and a better start in life ; to ensure a fuller measure of education and opportunity for young people ; and to provide means for all of developing the various talents with which they are endowed and so enriching the inheritance of the country whose citizens they are.'

Generous language indeed and likely in some quarters to provoke one or other of two doubting responses. The cynical and disillusioned may say bluntly : ' Claptrap ! ' while the cautiously hopeful may query : ' Is this really practicable ? Can we act up to it ? '

To the first, it may be answered that this conception of a good life for the individual, protected in his rights when he needs it and provided with means and facilities by the laws, is no new thing. It represents a force which can be traced in powerful working through many centuries of English history. With some periods of intermission, the action of the State in England has always had some touch of a paternal character, and the English citizen has never lacked readiness to take action on his own account whenever he has felt that Government by its action has violated the conditions of the good individual life, or by neglect has failed in its duty to provide and maintain them.

Nevertheless, there are features in the declaration I have quoted above which, in a relative sense at least, may be regarded as new, as an advance upon earlier policy. One is the comprehensive sweep of the conception stated so as to cover the whole population. There is no trace in it of such nineteenth-century language as ' the instruction of the children of the labouring poor,' nor of the nineteenth-century attitude which looked upon the care and education of needy children as a function of charity rather than as a responsibility resting upon the whole community.

There is, doubtless, ground for the view that the industrial revolution in England had the effect of excluding large sections of the people from the full enjoyment of their English inheritance. Much nineteenth-century language about the 'Poor,' for instance, would seem to suggest that these were made of another kind of clay. So it comes about that the massive social movement of the last two generations, radical as it may appear to some, has, in fact, a profoundly conservative character. For part, at least, of its driving force is to be found in a powerful resolve among masses of English folk who had come to feel they were disinherited, to recover their full inheritance. If this surmise is correct then there is little to fear from, and much to be gained by, such a movement.

The declaration quoted above gives expression to a second relatively new emphasis upon an old principle—the special concern for children. The resolve that they shall be trained and cared for from the first as inheritors of all that belongs to the good life is not due solely to generous impulse. There is also behind it a certain sense of compulsion, of national necessity, of acting, as a Spanish thinker puts it, 'at the height of the times.'

But of the strength of the impulse itself there can be no doubt. So we come to the other question that the White Paper statement of objective might provoke : 'Can we do it ? Is it reasonable to try ? '

On the point of reasonableness the objection is sometimes made that while we can accept all-round personal development as an ideal aim, the demands and pressure of day-to-day society are very much out of accord with that aim. Home conditions, the circumstances of employment (or unemployment), the experiences of crowded urban life, it is argued, will necessarily defeat for many the achievement of any such purpose.

To this it can fairly be answered that, taking the traditions and the pervading influences of English society as a whole, they are favourable to the idea of an all-round development. Further, as we become more aware that this is so, and more aware of those features of English life that are in conflict with the ideal, we set ourselves in increasing degree, by various modes of social action, to harmonize the diverse influences that play upon the young so as to make our whole society more genuinely educative in all its parts and functions. A harmonizing effort of this kind is clearly traceable in the wide range of controls set up by the Act of 1944.

Agreeing then, that the aim is reasonable, we have now to ask how far it is practicable. The answer involves a survey of present resources as they are contemplated by the Act. The remainder of this chapter is devoted to such a survey.

To conclude this section, however, let us assume that the official declaration from the White Paper can be accepted as a fair statement of the educational aim. Properly interpreted and articulated the official statement gives us all we need. The diverse wealth of specific possibilities that it covers can be best realized by working out its implications as it is applied in practice. Let us now see what possibilities are open under the Act of 1944. What follows is a sketch of the system as it is now shaped. Its parts and their respective functions can be described conveniently under four heads: the schools, the local authorities, the central Ministry, and the teachers. Topics which are dealt with elsewhere in this book will be passed over lightly.

The Schools

In spite of all the rationalization that the Act was able to effect, the ill co-ordinated growth and improvisations of the past still leave their traces. One can endorse readily enough the plea for ‘ variety ’ so long as it is a variety springing from a diversity of genuine educational effort and not from motives of social exclusiveness or the entrenchment of privileged interests. Present variety is not all to be justified on purely educational grounds. Indeed, it becomes daily more clear that, from that standpoint, we have not variety enough.

Existing schools fall broadly into two classes :—

(*a*) Publicly provided or aided schools.
(*b*) ‘ Independent ’ and private schools.

(*a*) In the publicly controlled system the Act marks an end of the ‘ elementary ’ school as a distinct form of provision for a social class, not fully organic to the rest of the system and maintained at a lower standard of expenditure and amenity. Further, at the next level (above the age of eleven plus) all education is to be administered as secondary and all pupils are to have education of secondary type. The upper limit of compulsion, at present the fourteenth birthday, is to be raised to fifteen by April 1st, 1947, and ultimately to sixteen.

Clause 7 of the Act lays it down categorically that education is to be organized for all in three stages, primary, secondary and ‘ further ’ education, and places upon the local education authority the duty ‘ to contribute towards the spiritual, moral, mental and physical development of the community by securing that efficient education throughout those stages shall be available to meet the needs of the population of their area.’

In such terms does the White Paper statement, already quoted, take shape as a statutory obligation. But taking practical *effect* is quite another matter. Local authorities were to present their plans for action to the Minister by April, 1946. Good judges estimate that anything up to twenty years of work is involved in the actual carrying out of plans if they are to give real effect to the intentions of the Act.

Definitions are commendably broad and simple. Primary education is 'full-time education suitable to the requirements of junior pupils.' Secondary (with a proviso made necessary by some possibilities in 'further' education), is similarly defined for senior pupils. 'Further' education (a very mixed bag) comprises all those forms of provision by the Ministry and the local authorities which serve the needs of people, young or old, beyond the age of compulsory school attendance.

Arising out of this general plan, there are some specific problems which will be of interest to readers of this book.

(i.) The primary stage is itself divided into two, the nursery-infant school and the junior school. There is much here that calls for clarification. The minimum age of compulsory attendance is five. Two points at once arise: the child at this age is not ready for junior school treatment, and yet for many if not most children, the guidance and care that can be given *before* the age of five by a school suitably organized, are highly desirable. Hence the Act requires that nursery schools or classes shall be provided wherever the need is proved.

Several issues here need to be clarified. In the first place it cannot be too strongly emphasized that a nursery school or class is something more than a nursery. It is a school, designed to provide under nursery conditions, education appropriate to that stage. It follows, though the fact is not always recognized, that a nursery school teacher is something more than a nurse.

Then, what is the precise nature of the distinction between 'nursery' and 'infant'? If it is an infant school from the age of five to the beginning of the junior stage, how does the type of training then given differ, if at all, from that at the nursery school level? Further, what of those children, a very large proportion as things are, who enter school for the first time at the age of five, not having been to the nursery school at all?

Thirdly, taking nursery and infant school as forming one stage, at what point do we make the transition to the more systematic and more seriously 'scholastic' junior school treatment? A common practice is to make it at seven, but the argument for deferring it to eight seems to be gathering support. It is not only that the child should be able to read and write when he enters the junior school; the needs of his personal development, it is argued, require that he should continue under nursery and infant handling until the later age.

If this is accepted and the transition to the secondary school takes effect at eleven plus, then the junior stage of the primary school is squeezed into a three-year course. The contention that this is not enough will then have to be faced quite seriously. Can the transfer to the secondary stage be deferred for a year? If there is nothing more than customary usage and administrative convenience behind the present practice the way might seem open for reconsideration on educational grounds.

This brief survey should be sufficient to indicate how numerous and important are the issues awaiting settlement at the primary stage. Any final determination of them will have to take into account social factors and considerations of physical growth and health, in addition to the more specifically educational factors.

(ii.) There is no space here to enlarge upon the great amount of leeway that has to be made up in the matter of buildings and equipment at the primary stage. The price has now to be paid for long years of weakness and neglect, of great inequalities as between one part of the country and another, and of persistent disposition to regard 'elementary' education as a service to be provided on the cheapest possible lines.

The result is a wide gulf between the intention of the Act and existing provision for making possible the kind and standard of primary education that it contemplates. There is no doubt of the intention. What has yet to be proved is the steadiness of public will and the willingness to shed ancient prejudice that reform will call for. Standards are now being set up. It is for us to satisfy ourselves that they are both suitable and attainable and then to brace ourselves for the prolonged effort that will be necessary to give them practical effect.

(iii.) At the secondary level (in the new universal sense of the word) similar problems of building, staffing and equipment arise, though somewhat less acutely, perhaps, than at the primary level. Here the great task that has to be faced is that of working out the different schemes of educational treatment that will be required for the many varities of need and aptitude that the adolescent population as a whole will reveal, and of ensuring that suitable provision is made for each type of treatment. A problem of peculiar difficulty to which all too little attention has yet been given is that of devising the right educational treatment—to the age of sixteen, be it remembered—for the lower levels of intelligence. These provide problems enough when they leave at fourteen. How much more when we have to keep them usefully and happily in school for two more years, and years of rapid development at that !

At the time of the passing of the Act, three kinds of publicly-supported schools were providing education beyond the age of eleven plus. Firstly, the secondary schools, administered under the secondary regulations of the Board. Since the Act of 1902 local authorities had rehabilitated old grammar school foundations and created many more new schools. Pupils from the elementary schools were admitted on a scholarship test which selected not more than about 15 per cent. With selected pupils and a higher standard of buildings, equipment and staffing, these schools achieved a high level of work for the maintenance of which in the new conditions every effort must be made.

Secondly, there were the junior technical schools, taking their selection from the elementary school at thirteen and offering courses to fifteen or sixteen which, while being genuinely educative, had a marked bias towards industry or commerce. Though there were never very many of them, the type has well vindicated itself and is now likely to be multiplied.

Thirdly, there were the ‘ senior ’ schools, set up in pursuance of the Hadow Report of 1926. They were administered under the elementary regulations and offered a course from eleven plus to the leaving age of fourteen. By 1944 about two-thirds of the senior pupils in the elementary system were thus provided for. It is impossible here to give even in outline a survey of all the new problems that arise in this connection. What is clear is that any final decision as to the forms of educational treatment that are to be provided at the secondary level, and as to the modes in which such provision is to be made, must carry with it implications of the first importance for the future of English society. The situation we are now facing is at once so novel and so complex that it may well be found wise to defer any settling of the permanent plan until a good deal of trial and experimentation has been carried through. In particular there seems to be growing doubt of the wisdom of adopting these types described above, divergent as they are in origin, tradition, status and social estimation, as providing the most desirable types for the new order.

(iv.) ‘ Further ’ education can be mentioned only to call attention to two forms of provision affecting youth generally. First, the requirement that boys and girls, unless exempted for good reason, shall attend for one day each week during the period between school-leaving and the eighteenth birthday, for further education at a new institution to be known as a ‘ county college.’

Second, the extended recognition of what is known as the Youth Service, covering a variety of forms of provision, official and unofficial, designed to assist young people in their personal growth, in surmounting the personal problems and difficulties they encounter and in securing for them the opportunities that a generously inspired community organization can offer.

There can be little doubt that in such provision, wisely worked out and generously conducted, there will be found valuable instruments of social and educational control and guidance peculiarly suited to the needs of youth in the present conditions of English society.

(v.) It should be added that by the Act local authorities are given power to set up boarding-schools or departments and to pay the fees of selected pupils at boarding-schools already in existence. In this connection it is very much to be desired that distinctions should be drawn between the various reasons which call for the boarding-school. There are reasons of social habit, of prestige, of parental convenience and so on. But we need also to investigate very closely the more strictly educational reasons. For what *type* of boy and girl is the boarding-school form of education most desirable? Oddly enough we may learn much that is valuable about this from a study of the needs of handicapped children and from the handling in Borstal schools and 'approved' schools under the Home Office of boys and girls who have come into collision with the law.

(*b*) The second group of schools, 'independent' and private, can be much more briefly handled. There is no very clear distinction between the two terms. Roughly, the independent schools are endowed foundations, some of them ancient and governed under an appropriate legal instrument. Most of them are represented on a body recently created, the Governing Bodies Association.

The private schools are much more mixed, much more diverse in standards and efficiency, and less is known about them.

What the two types have in common is that they receive no public aid and do not operate under the Ministry's regulations. Under the Act the Minister takes power to register all such schools (subject to certain exemptions), to prohibit unregistered schools and to remove from the register any school against which complaints justifying such action have been substantiated.

The large foundations—the 'public' schools—have been expressing for some time a desire for closer relations with the publicly provided system. A committee set up by the then President of the Board of Education, under the chairmanship of Lord Fleming, investigated the possibilities and reported in 1944.

No decisive action has yet been taken upon the recommendations. It would appear that the time is not yet ripe for establishing permanent relations between the independent schools and the general educational system. The new order set up by the Act needs time to reveal its possibilities ; social, economic and cultural changes, now so marked, must be assessed and understood ; and the independent schools themselves will need the time to watch developments and take thought for their ultimate attitude.[1]

For the purposes of this book an account of the school system exacts a preponderant share of the available space. Our remaining three headings can be dealt with more shortly.

The Local Authorities

It must always be remembered that the English system of education is not a state system. The State as such does not provide schools, pay teachers and prescribe curricula. The tradition and the fact are that it is a *community* system, the concern and immediate responsibility of communities among which, although counties and county boroughs so largely predominate, are to be found churches, voluntary associations and historic bodies like the London city companies. The State co-ordinates, aids, inspects and regulates but it does not directly provide.

In the new order set up by the Act there are 146 Local Authorities for education in England and Wales, all of them counties or county boroughs. Prior to the Act there were nearly 200 more, having authority over elementary education only. Always an obstacle to progressive rationalization since they were set up by the Act of 1902, their continuance was quite incompatible with the conceptions that are to govern the new order. But by an ingenious arrangement in the counties, a system of divisional executives and 'excepted districts' provides continuing scope for public-spirited people for whom there is no place on the education committees of the fully responsible authorities.

While an education committee must have a majority of members who are also members of the county or borough council, it must also ensure that it comprises a sufficient number of members who have special experience and knowledge of education. This is usually achieved by the co-option of persons who are not members of the council.

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[1] It has not been possible in this survey to give space to any discussion of purely *administrative* distinctions between schools of various types. There are many such, sometimes irritating, but in the circumstances quite unavoidable. The arrangement with the Churches that was involved in framing the Act, the diversity of historic growths that had to be provided for, and the differing financial relations of schools both with the Ministry and with local authorities, all contributed to the necessity. There is often little or no educational difference between schools that, administratively, have to be differently classed. Readers who seek particulars are referred to Ministry of Education Pamphlet No. 2, 'A Guide to the Educational System of England and Wales' (H.M. Stationery Office).

As regards the functions of these authorities, the general effect of the Act is to impose as duties what were formerly powers and to add new powers and duties. Duties cover the whole range. Each authority is required to study every form of educational need in its area and to present for the Minister's approval a detailed plan for meeting them.

On the present basis of grant aid, especially since an increase of 5 per cent. in the standard percentage of Exchequer aid, more than half of the cost is borne by the central Government. The balance is charged to local rates. Grants at a more liberal rate are payable for certain services such as school milk and meals, and poorer areas are eligible for additional grants in relief.

One effect of the Act with the enlarged range of duties and the higher standards of achievement it imposes, will almost certainly be to throw into strong relief the disparity of local resources as between the wealthier and the poorer areas. True equality of opportunity is hardly attainable until some remedy is found. But that may well involve a somewhat radical reconstruction of the whole system of local government in England and Wales, a project not likely to be undertaken just yet.

The Central Ministry

A Minister replaces the former President of a shadowy Board of Education that seems never to have met as such. Corresponding to the duties now imposed upon local authorities the Minister receives powers of direction and control. In the whole Act there are no words more significant of its underlying purpose and intention than those which occur in the very first clause. He is there charged 'to promote the education of the people of England and Wales and the progressive development of institutions devoted to that purpose, and to ensure the effective execution by local authorities, *under his control and direction*, of the national policy for providing a varied and comprehensive educational service in every area.' (Italics mine.)

For this comprehensive duty appropriate powers are conferred. For instance, the Minister may require the payment of teachers' salaries upon an approved scale and may even veto a proposed appointment of a chief education officer for a local area if he sees good reason for doing so.

In educational as distinct from administrative policy the Minister is advised by two statutory committees, one for England one for Wales. Unlike the former Consultative Committee they can advise on their own initiative as well as in response to a specific request from the Minister.

Administration for Wales and Monmouthshire is provided for in a separate department under the Minister.

The inspectorate provides the Ministry with its eyes and ears. His Majesty's Inspector of Schools is the holder of an office peculiar to this country. He is not an executive officer. He gives no orders and instructions but he 'advises' local authorities, inspects schools and 'reports,' in theory at least, to His Majesty. It is an office of great influence and importance carrying power that is no less real for not being expressly conferred. Its value can be better appreciated if one knows something of the working of systems where the inspector is an executive arm of the central authority.

Teachers

This heading comes appropriately last. The whole great plan remains on paper unless there is a supply of teachers adequate in numbers and quality to work it. On both grounds there is urgent need for action. A large increase in numbers is needed practically at once, and sweeping improvements in the preparation of teachers for their work are, admittedly, long overdue. The number of *additional* teachers required is conservatively estimated at 70,000. These are needed for the raising of the school age, for reducing the size of over-large classes, for staffing the new county colleges and for other developments. In addition, the wastage of the war years has to be made good.

The Ministry has instituted a system of emergency colleges for this purpose to give intensive training to selected men and women, older than the ordinary entrants and coming mainly from the Forces. Excellent material is forthcoming and these colleges are at work. But the number will need to be very largely increased, and that very rapidly, if the hopes roused by the Act are not to be dangerously deferred.

Plans for reorganizing and improving the training of teachers generally have been worked out by a committee under the chairmanship of Sir Arnold McNair, which reported in 1944. The main needs are to break down the long-continued isolation of the training institutions, to bring them into more organic and vitalizing relation with the rest of the educational system and to improve greatly their equipment, staffing, standards and amenities.

One half of the committee recommends strongly that the Universities should be asked to assume a supervising responsibility for the preparation of teachers, each university taking charge of its appropriate region. There is reason to believe that the Ministry favours this plan. The extent to which the universities are prepared to play their part in it has not yet been revealed.

One particularly important recommendation of the McNair Committee that has already been acted upon concerns the salaries of teachers. In view of the implications of the new order and the need to increase the attractiveness of the profession, the Committee recommended the institution of a basic salary scale, with allowances for special qualifications and responsibilities, for all teachers recognized as qualified, at whatever level and in whatever school they might be teaching. The joint committee for negotiating scales (Burnham Committee) has since met and adopted a scale on these lines. The Minister has now given effect to the scale.

There are hopeful indications that efforts to improve prospects in the teaching service are having their effect. There are equally welcome indications that able young men and women are responding to an increasing degree to the kind of call that such a service can convey. But the due fulfilment of these hopes depends to a very large extent upon continued improvements in the schools themselves. We are most likely to secure both ends, good schools and good teachers, if we pursue them together.

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CHAPTER XVIII

THE CARE OF THE HOMELESS CHILD

THE problem of homeless children to-day is so complex, and the confused situation changes so rapidly, that it is difficult to give an accurate survey of the position in England which will not shortly become out-dated. The administrative methods are many, and include the use of rate-aided and grant-aided public institutions, either under Central or Local Governmental control, and a medley of charitable organizations to which the State occasionally extends benevolent criticism or admonition.

It is now an accepted fact that children not only require a modicum of the world's material goods and their fair share of food, clothing, and living space, but that it is essential for them to have the basic security of contented homes and sympathetic normal parents. Although many young people make remarkable adjustments to life in incredibly undesirable surroundings, it is the duty of this country to protect and educate all deprived children in such a way as to insure as far as possible that they are not irretrievably harmed by their adverse circumstances. The rock upon which their feet are placed may be a hard one, but they must not be asked to stand on shifting sand.

War has inevitably disrupted normal family life, but even in the years between the wars many homes were beginning to show signs of ' dry rot,' and by 1939 this disintegration was having a repercussion on the lives of thousands of children.

Homeless, unwanted, and de-valued children can be classified into six main groups, although many individual cases will fall under more than one category. In considering the groups it should be borne in mind that these children are to be found in all types of society and that they are not necessarily impoverished. The dangers and difficulties of broken family life amongst those with sufficient incomes to make adequate material provision for their children do not come to the notice of the general public. These families, however, are a serious factor in the whole problem, and the State occasionally meets their children in adult life under somewhat unfortunate circumstances.

The following six categories cover the field of those children who are, or should be, wards of the community and towards whom the public must feel a sense of responsibility :—

(1) Illegitimate children.

(2) Criminally neglected or deserted children.

(3) Children whose parents are unable to maintain them (technically known as destitute children).

(4) Children of divorced or separated parents.

(5) Children of neurotic, psychotic, or physically disabled parents.

(6) Orphans.

Illegitimate Children. Some illegitimate children remain in the homes of their mothers, and are accepted by their families, but a large number are placed with registered foster parents who receive weekly payments for them. If the mother has taken out an affiliation order against the child's father, he has either to pay into the Court or direct to the mother a weekly sum towards the child's maintenance. Normal home life is not possible for these children ; mothers usually reject them consciously or unconsciously before and after birth, and unless their environment and education compensate to some extent for their loss of affection this sense of rejection makes them breeding grounds of discontent and resentment ; in later life they may take an anti-social attitude towards existence.

The State exercises no special supervision over the illegitimate child. Child welfare centres can offer advice and help, and children under nine years placed in the care of registered foster parents come to the notice of the Public Authorities Welfare Officer appointed for the inspection of such foster homes ; after the age of nine no further supervision is demanded. Probably a large number of such children become the direct responsibility of Public Assistance Committees or charitable organizations, and some are legally adopted under the Adoption of Children's Act, but it is difficult to obtain exact information on this point. The number of illegitimate births in England and Wales had risen in 1945 to 43,120.

Deserted or Criminally Neglected Children. Since the war, 500,000 cases of parental neglect or cruelty have been known to the National Society for the Prevention of Cruelty to Children, and 1,000 parents have been charged and convicted.

Although a comparatively small number of parents were sentenced, the home conditions of the remaining cases were sufficiently unstable to meet the attention of the Society. In addition to these figures should be added abandoned or deserted infants who become chargeable to the Public Assistance Authority.

Destitute Children. Such children may only be in need of temporary help owing to misfortune of their parents, and a proportion of such children will be in receipt of 'outdoor' relief paid to their parents through the Public Assistance Committees. These have comparatively happy, although impoverished, home conditions, but the greater number of destitute children are provided for by Public Assistance Authorities in residential homes or schools, or in foster homes, or by voluntary charitable organizations.

Children of Divorced or Separated Parents. Such children are becoming an increasing problem. Home conditions may reach a crisis which results in divorce, separation, or even the complete disappearance of a parent; the children are then deprived of the elemental rights of either maternal or paternal security. This situation coupled with poverty, partial or entire, does not allow either side to make adequate provision for the children, who must inevitably become the responsibility of Public Authorities or charitable organizations. The yearly increase in the number of divorce cases makes the gravity of the situation obvious. In 1943, 9,999 such petitions were filed in the Divorce Courts (last available figures) and public notice has also been drawn to the fact that from 1942 to July, 1945, about 48,500 applications for assistance in divorce proceedings had been accepted by Command Legal Aid Sections at home and overseas. This large number of applications is a tragic but symptomatic feature of the disturbance brought about by war in the field of family relationships.

Children of Neurotic, Psychotic or Physically Disabled Parents. A far larger class than is usually recognized, it includes those whose parents have been certified under the Lunacy Act, and who have been discharged but are still unfit for family responsibility, and the children of chronic alcoholics, neurotics and the physically disabled. Many children of such parents are, or should be, educated away from their homes.

Orphans. Children who have lost both parents and who have no relatives willing to provide for them must necessarily become the responsibility of the State or of a charitable society. Those who have one parent living are also often in need of help, either owing to difficult home circumstances or, in the case of the children of widows, inability on the part of their mothers to maintain them.

'Care and Protection' Children. Young Delinquents. These children should not be regarded as a group in themselves, as the majority are recruited from the categories mentioned above. Either their home conditions are so undesirable that they have been brought before a Juvenile Court as being in need of care or protection and have been removed from the custody of their parents, or they themselves have committed offences against the public by robbing its orchards, stealing from its chain stores, and occasionally offending against its sense of decency.

Further particulars as to the placement of these children will be found in Chapter XIX.

Type of Administrative Care

Provision for the care of homeless children falls into the following categories, and all types of homes referred to are used both by Public Authorities and voluntary organizations.

Grouped Cottage Homes. These consist of a number of small houses containing twelve to twenty children. The houses are built round a central administrative block. Each group of children is in charge of a house-mother and an assistant house-mother, and the whole colony is supervized by a superintendent and his wife. The children usually attend the neighbouring schools, but a few authorities prefer to establish their own primary school on the premises. Some effort is made to preserve elements of family life in the cottages but the units are usually too large and the conditions too artificial for this to be successful. Children brought up in such large self-contained colonies remain a segregated group, deprived of all knowledge of the every-day happiness of village, town, or home life.

Scattered Homes. These consist of houses containing from twelve to forty children. They are situated in different areas of the county, and are under the direction either of the Local Authority or a charitable organization to which they belong. The Local Authorities usually employ an itinerant superintendent who is responsible for the general welfare of the homes, each of which is in charge of a foster-mother and an assistant foster-mother, or a married couple.

If not too large these homes have the possibility of retaining some semblance of home life, but it is difficult to ensure adequate supervision of scattered homes and the system is therefore open to grave abuses.

Large Institutions. Some Authorities and voluntary organizations still provide for their homeless children by housing them in large buildings holding several hundred. Some date back a century and are of the worst possible ' barrack ' type of building, whilst others have been recently built and equipped according to modern standards of hygiene and comfort.

Such large institutions and the type of organization which they necessitate make it impossible for any child to have that sense of individual relationship to an adult essential for all children but more especially required by homeless children. If these institutions were prepared to give a first-class education and provide a wide variety of stimulating intellectual and physical activities they could be used as boarding schools in a national scheme for children without homes, providing that suitable foster-parents were available to whom every child would return for normal school holidays. The foster-family could also keep in touch with a child during the term and form the invaluable link between home and school life so necessary to some types of children.

Foster-Homes. Many Local Authorities and some voluntary societies consider permanent foster-homes to be the best solution to the problem of homeless children, and approximately one-fifth of all children chargeable to Public Assistance Committees are dealt with in this way. Given adequate supervision of the homes by qualified welfare officers, this method of placement is one of the most satisfactory as it can meet many of the elemental needs of childhood, normal family life, affection and a place in the foster-parents' immediate social circle. On the other hand, some children will not accept ' substitute ' parents and consciously or unconsciously set up barriers between themselves and their foster-parents ; friction ensues and such children eventually have to be transferred to a new home. Here the same situation repeats itself, thereby increasing the children's restlessness and insecurity ; eventually they find their way back to an institution from which it was hoped to save them.

The superior working-class home willing to receive a foster-child provides good material conditions and kindly affection, but the environment may lack stimulus and variety for the very intelligent type of child, or may be deficient in the skilled understanding and wisdom required to re-establish the troubled child.

Adoption. No survey of the needs of unwanted children is complete without reference to the vexed question of adoption. Children can be given a home by legal adoption and there is much to be said in favour of such provision for children who are homeless from infancy. It is essential that all adoption transactions should be in the hands of recognized adoption societies experienced in the difficulties and risks involved, for if a child is wrongly placed his whole life is irrevocably spoiled. Too often arrangements are left in the hands of third parties who have not sufficient knowledge to take into account all the factors involved in successful adoption, and some of whom may undertake negotiations for pecuniary gain.

Administration

Both State and voluntary agencies function in planning for the protection and education of deprived children, but the clumsy administrative machinery and the overlapping of the responsibilities of respective ministries introduces a regrettable element of chance in determining the fate of these children. The following table shows the framework of the Administration at present in operation by Local Authorities.

TABLE 17

Responsible Ministry	Local Authority	Type of child	Method of disposal
Ministry of Health.	Public Assistance Committees.	Destitute and abandoned children. Children in need of temporary residential care. Children of widows, or separated parents who are obliged to go out to work.	Residential Public Assistance schools of various types. Boarding out with foster-parents. Certified voluntary school recognized by the Ministry. Public Assistance Institutions (principally used for destitute infants under three years or as temporary accommodation for older children ; an undesirable practice used as an emergency method of disposal).
Home Office.	Local Education Authority.	(*a*) Children in need of care and protection committed by the Juvenile Courts to the care of the Local Education Authority as ‘ fit persons.’	Boarding out with foster-parents.
		(*b*) Delinquent children charged at the Juvenile Courts and found to require residential care.	Committed to an Approved School or sent to a hostel on probation.
Ministry of Education.	Local Education Authority.	(*a*) Maladjusted children. (*b*) Retarded children. (*c*) Physically handicapped children who in addition to these disabilities are homeless, destitute, or delinquent.	Residential special schools.

Voluntary Societies making Provision for Homeless or Unwanted Children. In addition to the provision made by Local Authorities there are about 900 homes accommodating approximately 52,000 children established by seventy-two voluntary agencies. This large child population is drawn from the same sources as children in state controlled institutions. The homes vary in type and range from such large organizations as the Church of England Homes for Waifs and Strays and Dr. Barnardo's Homes to small orphanages for a dozen children. They also vary much in character and quality ; some are denominational, others accept children of all creeds, some large societies make well-classified provision for the different types of children they receive, others are staffed by underpaid-overworked women with little knowledge or understanding of the needs of the deprived child. A few are in the van of pioneer work amongst children, others are still running homes on the methods of the Charity Home of early Victorian days.

Responsible Ministries. No less than seven Ministries are responsible for the welfare of children in voluntary homes :—

The Ministry of Health—for all voluntary homes receiving children from Public Assistance Committees.

The Ministry of Education—for voluntary homes maintaining their own schools on the premises.

The Home Office—Children committed to the care of the Local Authority as 'fit persons.' This Ministry also has power to inspect all homes and schools not inspected by other Government Departments, but in point of fact up to the present time many have escaped all government supervision.

All voluntary homes for children have to *register* with the Home Office although they may be inspected by other Ministries (with the exception of endowed schools or homes who do not receive charitable funds).

The Ministry of Pensions—responsible for all orphans of the 1914 to 1918 and 1939 to 1945 wars who are in voluntary homes or placed with foster-parents.

The War Office, Admiralty and Air Ministry are responsible respectively for the motherless children of service men in voluntary homes.

In 1945 the Home Office issued new Regulations under the Childrens and Young Persons (Voluntary Homes) Regulations. These require that full information covering education, training and management of children, and qualifications of staff shall be submitted annually to the Home Office.

The Future

Neither public authorities nor voluntary charitable organizations for the homeless and unwanted child are yet meeting the problem with sufficient efficiency, knowledge or foresight.

Existing machinery is numerically inadequate and lacks both quality and variety, and elasticity. Excellent work is achieved in a few homes, schools or foster-homes, but far too many remain in ignorance of the essentials necessary to the well-being and mental health of any child, and particularly of the child deprived of his home birthright. Expert knowledge and wisdom must be combined with affection and sympathetic understanding if the devalued child is to have confidence restored in the adult world around him.

No one type of education or re-education will overcome the widely differing idiosyncrasies and temperamental difficulties of insecure children. Schemes for their welfare co-ordinated by one Ministry would help to clarify the various types of children requiring guardianship or supervision and would assist Local Authorities and voluntary societies to make comprehensive plans for their welfare.

One of the first necessities in any scheme of unification and re-organization of the administrative service should be the establishment of regional, reception or allocation centres for all homeless children.

Such centres could either serve a county, or in less populated districts, the centre could serve a combined area. They should be under the direction of the Child Guidance Service of the county in which they are established.

This method of sorting homeless children would be a basic way of introducing a patterned procedure to the problem by ensuring that the psychological and physical needs of each child were assessed by those with the required medical, psychiatric and social qualifications and experience. The period of residence at the centre would vary from a few days to several weeks. A normal child with a comprehensive record from school and welfare worker would after a medical examination, and the necessary intelligence tests, and some observations on his social reactions to the group, be allocated to the right type of school or foster-home without further delay. The same procedure would apply to a mentally retarded or physically handicapped child showing no peculiar signs of emotional difficulties. A child with a history of behaviour difficulties, or one from a severely disrupted home background might have to remain under observation for a longer period.

A report on the child would then be forwarded to the responsible authority or charitable organization and advice given on suitable placement.

Such recommendations would include placement in :—

(1) Foster-homes—for the fairly well-balanced child of normal ability.

(2) Residential children's communities offering good educational and recreational activities especially suitable for older boys and girls of superior intelligence who would respond well to the stimulus of an organized communal life.

(3) Small hostels for maladjusted and fearful children, with special difficulties (such as enuresis) which make them unable to adapt themselves either to foster-homes or large schools.

(4) Special schools for mentally retarded or physically handicapped children.

Apart from their primary functions of finding a suitable environment for each child, reception centres could also show what measures were necessary or needed to improve the quality and quantity of existing facilities and institutions for the education of the homeless child, and their work might well throw fresh light on the magnitude of the problem.

Foster-children of the State should be amongst our most honourable responsibilities, but the existence of neglected childhood must not be regarded as an inevitable outcome of modern civilization ; much may be done for the re-education of defaulting parents by means of close co-operation with them by doctors, teachers and social workers. By so doing we may eventually be able to reduce the mortality amongst children's minds and souls with the same success as we have cured physical diseases, and reduced infant mortality.

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CHAPTER XIX

JUVENILE COURTS

OFFENCES committed by children (eight to fourteen years of age) or young persons (fourteen to seventeen) [1] are heard in specially constituted Juvenile Courts. The age of criminal responsibility is eight, *i.e.*, no child under that age can, in the eyes of the law, commit an offence. The Court must not sit in the same building at the same time as an Adult Court. Many Juvenile Courts in fact meet in a building quite separate from the Adult Court and in an ordinary room with the magistrates sitting at a table. There is a specially constituted panel of Juvenile Court magistrates for each area : they are elected from the main body of the magistrates, and it is the desire of the Home Office that they shall be of 'fatherly rather than of grandfatherly age.' This ideal has perhaps become rather less remote in the last few years. The bench consists of three magistrates (one of whom must be a woman), and the public is excluded from the Juvenile Courts. The Press has the right to be present but may not publish names, addresses or photographs of juvenile offenders.

A child or young person may be charged with any offence which would be punishable in the case of an adult. Those over fourteen have the right to trial by jury in certain cases—a right which is practically never exercised. The Juvenile Court may deal with every type of offence, however serious, except murder. There is, of course, a right of appeal to Quarter Sessions against the decision of a Juvenile Court. There is also the same right to grant free legal aid as in the Adult Courts. Some Courts also pay from the Court poor box fees of expert witnesses on behalf of the defendants. The need for this arises only on rare occasions ; it is, however, usually desirable if a boy or girl over school leaving age has been found to be certifiable under section 8 of the Mental Deficiency Act that, if the parents do not agree with the diagnosis, they should be given every opportunity to call expert witnesses on their behalf. The Courts are not the maid of all work of the social services but the impartial administrators of justice who may sometimes give a decision against a statutory authority and must always be concerned with the interests of the child and his sense that he has received justice before everything else.

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[1] These terms are not used in their precise sense in the text unless the context so requires.

The simplicity in which the Juvenile Court meets is in some ways deceptive because the actual procedure is identical with that of the Adult Court up to the time of the finding of guilt. That is to say, the rules of evidence apply in the Juvenile Courts in the same way as in the Adult Courts. Children are on the whole more truthful than adults, and the majority plead guilty to the offence with which they are charged. A wise Court will always see that the nature of the charge is carefully explained to the child, and hear exactly what happened if the child elects to tell his story. The law is very precise about the ingredients which constitute an offence in its eyes, and on occasion it happens that the law sees innocence where the child sees guilt. In addition to the general presumption of our law that a person is innocent until he is proved guilty, the onus of proving that he acted with guilty intent rests with the prosecution in the case of anyone under fourteen. The onus is the other way round in the case of those over fourteen. When a juvenile offender pleads not guilty, the Court will usually give him considerable help by cross-examining police and other witnesses on his behalf, and by asking him if he would like the case adjourned to call witnesses. The oath is still retained in the Juvenile Courts and many children suffer much bewilderment when they have to be confronted with the choice of taking the oath and being asked questions, making a statement without being cross-examined or saying nothing at all. Opinion is very much divided as to the necessity of continuing in the case of these Courts, the elaborate safeguards of the law against a wrongful finding of guilt. So soon as guilt is proved, the Juvenile Courts are enjoined by Children and Young Persons Act, 1933, to ‘ have regard to the welfare of the child ’ in the action which they subsequently take. This does not mean that in a doubtful case they may find a child guilty in order that they may ‘ welfare ’ him. It has, however, seemed strange to many that the offender should be so carefully protected against this exercise of concern for his welfare. The case for so doing is that the Courts exercise the ultimate sanction of compulsion : they and only they can separate a child from his parents without the consent of either party, and can even take from a parent his legal guardianship of the child. Such powers require very careful safeguards, though the price may be heavy in terms of children left in homes where they will not have a dog’s chance, because no case could be proved in a court of law.

There is a further aspect of the dilemma which causes concern to many. The actual commission of an offence may be merely a comparatively unimportant symptom of a variety of things that have gone wrong with a given child. If there is not sufficient evidence to bring him before a court, or if the offence is not proved, he may continue to live unprotected from his parents or himself or his environment. Even if the offence is proved it may be something in itself quite trivial, yet his whole antecedents may show that he would have a far better chance in, for example, an approved school. But the child's and the parent's sense of justice is likely to be outraged if he is 'put away' for three years for stealing sixpence. 'Welfare' and 'justice' are unhappy companions when the first may mean some massive change in a person's whole way of life and the second seems to the average child and his parents making the punishment fit the crime.

Victor Hugo said 'Society stands in the dock with every criminal.' Would that the parents stood in the dock with every child! Much of the delinquency of small boys is due to natural high spirits which find no right and proper outlet in crowded houses and crowded cities, built for adults and not for children. A good deal of the sexual misbehaviour of adolescent girls may also be genuinely beyond the control or understanding of their parents. But, by and large, the low mentality or physical health or poor standards or defective family relationships or selfishness and irresponsibility of parents visits the sins of the fathers on the heads of the children. The experience of the Child Guidance Clinics that their work is just as much concerned with changing the attitude of parents as of treating the children is echoed by everyone who knows the Juvenile Courts. That is to say, a certain amount of delinquency is of a nature which the offender 'will grow out of,' though even this is all the better for being sensibly handled in its early stages, but a great deal more delinquency is a symptom of unsatisfactory relationship between parents and children, which in its turn may be partly the product of bad social conditions. Merely to punish for the offence without trying to mitigate the causes would be as constructive as birching to cure chicken-pox. There also appears to be a close relationship between low mentality and child delinquency. This may be illustrated by some very remarkable material collected by the Bristol Education Committee contrasting over the year 1944–45 all cases (313) remanded by the Juvenile Court with unselected population samples. The results are :—

		Per cent.
1. Superior and normal (I.Q. 85–115 and over)		
	general population .	84
	delinquents . . .	42·1
2. Very dull (I.Q. 70–84)	general population .	13
	delinquents . . .	38·7

		Per cent.
3. High grade feeble-minded (I.Q. 55–69)		
	general population	2
	delinquents	16·6
4. Mentally defective (I.Q. under 55)		
	general population	1
	delinquents	2·6

It is safe to assume that a large proportion of these children are being brought up in homes of low standard and that neither there, nor in the ordinary large class at school, will they receive the careful training needed to enable them to hold their own without getting into trouble in the complexities of city life.

There are four separate groups of children and young persons brought before the Juvenile Courts :—

(*a*) Those who have committed an offence.

(*b*) ‘ School attendance cases.’ Under the Education Act, 1944, it is the duty of a parent to cause his child ‘ to receive full-time education suitable to his age, ability and aptitude.’ Where he fails to do so, and where all measures taken by the Education Authority fail, he may be prosecuted and the child brought before the Juvenile Court to be dealt with as though in need of care and protection (see under (*d*)).

(*c*) Those summoned by their parents as being beyond control. In such cases the parent has to prove to the satisfaction of the Court that the child really is beyond control. He cannot use a summons as a convenient means of getting rid of an unwanted child until he leaves school and is able to earn. The usual situation consists of staying out late, truanting from school or refusing to work, refusing to get up in the morning, not washing, lying, cheeking Mum and quarrelling with brothers and sisters. There is no lower age limit, and children of six who were wandering away from home have been found to be beyond control.

(*d*) Those brought before the Court by the police, the Education Authority or the N.S.P.C.C. as being in need of care or protection. In such cases it is necessary to prove that the child has no parent or guardian or one who is not exercising proper care and guardianship, and he is therefore either falling into bad associations or exposed to moral danger or beyond control. ‘ Moral danger ’ includes being found destitute or wandering or loitering or begging. In effect, this clause means that the community through the courts assumes responsibility for those young people who are going astray (though not necessarily becoming delinquent) because they have no one to look after them or because those who should do so are ineffective. Here the initiative rests with certain authorities, whereas in the preceding group it rested with the parents. There is often very little difference in the actual circumstances between the two groups. Family relationships must have become very bad before parents will bring their own child before a Court, yet these parents at least recognize the need to seek outside help. Girls who are going with bad companions or having sex relationships have come before the Courts in increasing numbers during the war on either summons. In this group there is no lower age limit at all: babies of a few months old may sometimes be before the Courts because they have been neglected or ill-treated by their parents and are in need of care or protection. Sometimes the adult Court has sentenced the mother to a short term of imprisonment for neglect (in 1944, 12,000 women were convicted of offences against their children) and this wholly unconstructive way of dealing with a situation which may be due to physical or mental sub-normality must often be supplemented by the efforts of the Juvenile Courts whose treatment resources are also limited.

It must be emphasized that the last two groups do not constitute offences. Both parents and children, however, need and receive the same safeguards against each other and against the Powers that Be as in criminal charges.

When a case is found proved, the Court may either deal with it straight away or else remand in custody or on bail for further inquiries. These latter include a school report from the local education authority, a home report from the probation officer (sometimes from the L.E.A.) and any special information, *e.g.*, a medical or psychological report which may seem called for in individual cases. Juvenile Courts are empowered to receive and consider written reports (after a finding of guilt), providing they communicate to the parents anything in such reports which influences the manner in which they dispose of the case. Sometimes those who write reports for Juvenile Courts complain that the magistrates have communicated to the parents comments or information which were intended to be highly confidential, thereby ruining the relations between the parents and the particular agency. Those who so complain fail to realize that the magistrates have no choice in the matter if the report makes them decide on a course of action which they would not otherwise have taken. No offender may be sent to a remand home as a punishment but only because he might disappear if given bail or because it is in his own interests, *e.g.*, to get away from his neighbourhood for a week or so, or in order to have a special report made. Remand homes are either provided by local authorities or by voluntary organizations. Most are very small and staffing presents a considerable difficulty particularly on the teaching side since, although boys and girls cannot be detained on remand for more than twenty-eight days before the case is settled, they may be there for months waiting for a vacancy in an Approved School. Courts which sit frequently in big towns naturally remand much more freely than country courts which meet infrequently from lack of customers and therefore usually have to hear a case and decide on treatment at the same sitting.

The forms of treatment available to a Juvenile Court are :—

(1) *Dismissal of the case*—only used in trivial offences where there is nothing special about the offender's circumstances.

(2) *Fining.* This involves a conviction and so cannot be combined with probation unless there is more than one offence ; very useful as a short sharp lesson with certain types of offender.

(3) *Birching* (*boys only*). Most of the best courts make no use of this.

(4) *Binding over, with or without probation.* This means that the offender undertakes to be of good behaviour for a maximum period of three years (usually one year) and to come up for judgement if called upon. The effect of this is that he may be called before the Court and otherwise dealt with for the original offence at any time within the period of the bind over. A Probation Order contains various general conditions—to lead an industrious life, not to associate with bad companions, and so forth. Failure to keep these is a breach of recognizances and in itself constitutes an offence. A bind over with probation means that the offender receives the skilled understanding and practical help of the Probation Officer to whom he reports regularly and who visits his home periodically. The Probation Officer acts as a friend, helps to improve family relationships, co-operates with the school or sees that the boy or girl has the right kind of job, and arranges for any special treatment which may be necessary. Special conditions may be inserted in individual orders, *e.g.*, to attend a child guidance clinic or to 'reside where directed by the Court.' Probation is the most commonly used form of treatment and is highly successful where, owing to shortage of staff, probation officers are not too overworked to give sufficient individual attention to offenders. Care or Protection and Beyond Control cases are placed under supervision instead of on probation, and are not bound over as they have committed no offence. Space does not permit an explanation of the effects of this but there is no great practical difference between them.

(5) *A Probation Order with a condition of residence is :—*

(i.) A hostel from which the boy or girl goes out to work. These hostels usually take twelve to twenty: where they are well run they are invaluable, especially for those at a difficult stage of adolescence who need a break from home, and sympathetic though sometimes firm handling. There are not nearly enough of such hostels. The war-time hostels for difficult children have proved invaluable : many are now closed but it is to be hoped that others will be started as part of the provision for maladjusted children under the Education Act, 1944.

(ii.) Lodgings—these may be used to tide over a crisis or a difficult period. A boy or girl from a bad or non-existent home may sometimes find a substitute home by such means.

(iii.) A Training Home—these give a residential six months' training in carpentry, gardening, etc., for boys, and laundry and housework for girls. They are sometimes a useful half-way house between a hostel and an Approved School.

(6) *Committal to a Place of Detention* (usually a remand home) for a maximum of twenty-eight days. This power is seldom used as it is rarely appropriate to a case.

(7) *Committal to the Care of a Fit Person* (commonly the Local Education Authority). This means that the legal guardianship is removed from the parents and vested in the Fit Person until the boy or girl is eighteen (the parent may apply to have the order revoked at any time if circumstances have changed ; the decision whether or not to revoke rests with the Court). This is an invaluable method of removing a child from a thoroughly unsatisfactory home and placing him with foster-parents. The Local Education Authority is responsible for his maintenance and welfare (there are certain minimum conditions laid down in the Boarding Out Rules). If the L.E.A. does not live up to its responsibilities, however, the child may jump out of the frying pan into the fire, as the O'Neill case tragically demonstrated.

(8) *Committal to an Approved School.* It is rare to send a first offender to a school until one or more of the foregoing methods have been tried. Children are in fact sent to a school for various reasons—because they are persistent offenders, because they live in a district where they have no reasonable chance, because they have bad homes or because they present behaviour problems. When local education authorities provide residential schools under the

new Act, it is to be hoped that these will cater for some of those who now go to schools connected with the Courts. These latter also take Beyond Control and Care or Protection cases, many of whom are far more 'depraved' than the offenders from whose contamination the well-meaning ignorant sometimes desire to save them. The schools are divided into Junior (10–13), Intermediate (13–15), and Senior (15–17). Some schools are run by L.E.A.'s and others by various voluntary organizations, including religious bodies (whether Christian or Jewish). Most schools are in the country and many are specialized according to the training given, *e.g.*, nautical, carpentry, gardening, farming, laundry and domestic work. There are one or two schools for girls of supernormal intelligence but none for boys. The schools are usually in ordinary houses adapted for the purpose, and the children go home on annual leave where home conditions make this possible. They may be released on licence after six months. The normal period in a school is eighteen months to two years, though there are a few short-term schools. Two or three schools have a hostel from which boys or girls go out to work for a time before they are finally licensed and return home. After-care is undertaken either by a member of the school staff or by after-care officers serving several schools. It differs in quality but is not generally wholly satisfactory.

(9) *Borstal*—a Juvenile Court may commit to Sessions for a Borstal sentence a boy or girl over sixteen who has committed an indictable offence for which he or she could be sent to prison and who is of criminal habits or associating with persons of bad character. A Juvenile Court may itself commit to Borstal for two years a boy or girl who has absconded from an Approved School. This power is only properly used where the offender appears to present too tough a proposition for any Approved School to cope with and would therefore have a deleterious effect on the others there. There was previously no classification of girls, who all went to the Aylesbury Borstal. (Recently two new Borstals for girls have been opened, one in Exeter and one in Kent.) The boys' Borstals are classified according to age, mentality, type of training and the character of the offender.

No psychological treatment is at present available at the Approved Schools, and there is no special provision either for the sub-normal or for maladjusted and difficult children, or for the rare cases of epileptic and pre-psychotic offenders.

The Juvenile Courts exist for the protection both of the child and of society. They have at their disposal the general services outlined above as well as others that may be available locally.

Probation officers are always willing to advise about a child who seems to be drifting into delinquency, and may even take him on as a voluntary case. It is very often, therefore, in the child's own interest that the services of the Court should be utilized rather than he should be allowed to form delinquent habits, as may happen if there is no one in his home or school environment with the wisdom or time to handle the situation constructively.

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CHAPTER XX

MILK

The beneficial effect of a liberal inclusion of milk in the diet of children has long been recognized by the medical profession, but it has taken the prospective shortages and deficiencies of a second world war to induce interested Government Departments to sponsor a comprehensive scheme for increased milk consumption. In the past, while fully aware of its advantages, doctors have often hesitated to encourage increased milk consumption, as they were dissatisfied with the hygienic quality of the supply available. Further, from time to time, milk-borne epidemics occurred and there was always the risk that if the milk supply was neither from tubercle-free cows nor pasteurized, it might contain living organisms of the bovine tubercle bacillus. The dangers of malnutrition were, however, deemed greater than those of infection, and the children of Britain are now receiving their full share of the supplies available.

Composition of Milk

Like most biological fluids, cows' milk varies considerably in composition. The supply in large cities, due to the effect of bulking for transport and processing, is much less liable to wide fluctuation than the supply of individual producer-retailers in rural areas. Even bulk supplies vary between winter and summer, the fat and total-solids content generally being higher during the winter months. Further, during the recent war there has been a definite fall in both the fat and solids-not-fat content of bulk supplies, which has been attributed to the lack of balance in the foods fed to dairy cows.

The percentage composition of cows' milk is given by Davies (1936) as follows :—

	Per cent.
Water	87·32
Fat	3·75
Sugar	4·75
Caseinogen	3·0
Other Protein	0·40
Ash	0·75

The fat is present as an emulsion suspended in a watery serum in which the proteins casein, lacto-globulin and mucin are in colloidal solution and lactalbumin in true solution. Lactose and mineral salts are also present in solution, although some of the salts are probably combined with the casein.

Milk also contains the following enzymes which play a part in controlling digestive fermentation: lipase, galactase, amylase, catalase, peroxidases and reductases.

The vitamins A, B_1, B_2, C, D, and E are also present in raw milk but the quantity is influenced by feeding, the conditions to which the cows are subjected, and the subsequent treatment of the milk.

The chief factors which induce variations in the composition of milk are :—

Breed of Cow. The Jersey and Guernsey breeds give milk which is much richer in fat and solids-not-fat than the milk of other breeds in Britain. The following figures are extracted from a more extensive table given by Davies (1936) :—

TABLE 18

Breed	Fat (per cent.)	Solids-not-fat (per cent.)	Ratio Solids-not-fat/fat
Jersey . .	5·14	9·59	1·86
Guernsey .	4·98	9·57	1·92
Ayrshire .	3·85	9·05	2·35
Shorthorn .	3·63	8·94	2·35
Friesian . .	3·45	8·48	2·46

Intervals between Milking. When cows are milked at equal intervals twice daily there is little difference in fat and solids-not-fat content of the milk of two consecutive milkings. On ordinary commercial farms, labour difficulties necessitate milking at unequal time intervals ; the longer interval at night is not infrequently of fourteen hours duration and the shorter day interval of ten hours. The morning's milk under such conditions generally contains 0·6 to 0·8 per cent. less butterfat than the afternoon's milk. It is important therefore to the consumer that the morning's and afternoon's milk should be mixed before sale.

The Efficiency of the Milking. First-drawn milk is the poorest and the last-drawn milk (strippings) the richest in butterfat content. It is important that the cows should be milked dry and, where hand stripping is practised after machine milking, the strippings be added to the bulk.

Other Factors. The solids content of the milk of any cow varies during the progress of lactation. Ill-health and particularly mastitis may seriously reduce the total solids of the milk. During the war, evidence has accumulated which indicates that the total-solids content of milk may be lowered by the unsatisfactory feeding of the dairy herds.

Bacterial Content of Milk

The bacteria present in milk from healthy cows are usually classified in the following groups :—

Acid-forming Bacteria. These ferment lactose with the production of acids, chiefly lactic acid, which combine with the calcium caseinogenate, causing it to precipitate in the form of smooth gelatinous curd. The chief members of the group are the lactic streptococci, but the lacto-bacilli, which do not increase rapidly under ordinary conditions, are of importance, particularly in connection with fermented milk drinks.

Gas-forming Bacteria. These ferment lactose with the production of both acid and gas, and the curd clot when formed is generally riddled with gas-holes. More acetic than lactic acid is produced in this fermentation. In this group are the coliform bacilli, but also included are certain anaerobes such as *Cl. Welchii* and *Cl. Butyricum.*

Proteolytic Bacteria. These organisms secrete proteolytic ferments such as rennin and casease. Rennin produces sweet clotting and casease digests the proteins present in milk. Normally these organisms are overgrown by the first two groups, but may take control in milk which has been produced under exceptionally clean conditions, and cause sweet clotting followed by casein digestion. Type members of this group are spore-bearing anaerobes such as *B. subtilis*, *Proteus vulgaris*, *Staphylococci* and *Micrococci.*

Alkali-forming Bacteria. Members of this group seldom gain control in normal milk, being overgrown by members of other groups. They can render milk alkaline by protein decomposition and some saponify the fat.

Inert Bacteria. Large numbers of bacteria found in milk appear to produce no visible change ; included in this group are the udder cocci and organisms derived from the water supply. Pathogenic organisms are included in this group. The pathogenic bacteria which may be present in milk are tubercle bacilli, *Br. abortus*, and mastitis streptococci, the most important of which is

Str. agalactiæ. The above are all usually of bovine origin. Milk may, however, act as a carrier of the organisms causing diphtheria, typhoid, paratyphoid, food-poisoning, and dysentery, which get into the milk during the handling process, either from infection from human carriers or from contaminated water supplies.

Grades of Milk

The sale of special grades of milk was first recognized in the Milk (Special Designations) Order, 1923, which was superseded by a new order in 1936. This order designated the following grades :—

(*a*) Tuberculin-tested, (*b*) Accredited and (*c*) Pasteurized. If the tuberculin-tested milk is bottled on the farm on which it is produced the word ‘ certified ’ may be added and when tuberculin-tested milk is pasteurized the word ‘ pasteurized ’ may be used. The designation ‘ accredited ’ milk (farm bottled) may also be used where such milk is bottled on the producing farm. Accredited milk when pasteurized loses its identity.

The production of designated milk is subject to licensing by local authorities and the conditions are set out in detail in the Milk (Special Designations) Order, 1936, together with slight modifications introduced in the amending Order of 1938. Conditions governing the granting of a licence to sell tuberculin-tested milk include the provision of a tubercle-free herd secured by the elimination of all animals reacting to the tuberculin test and maintained by subsequent yearly testing. In addition, the animals are subject to veterinary inspection at intervals of not more than six months. For accredited milk, every animal in the herd must pass a clinical examination by a veterinary surgeon at intervals of three months, and all animals showing evidence of disease be segregated or removed from the herd.

Milk sold under the special designation ‘ Pasteurized ’ shall be retained at a temperature of not less than 145° F. and not more than 150° F. for at least thirty minutes and be immediately cooled to a temperature of not more than 55° F. The milk shall not be so heated more than once. Indicating and recording thermometers shall be inserted in the milk flow-line at places required by the local authority granting the licence. Temperature records shall be preserved for not less than one month.

Standards for Designated Milks

For Tuberculin-tested and Accredited Milk. (i) The sample taken between May 1st and October 31st must not decolorize methylene blue in less than four and a half hours and between

November 1st and April 30th in less than five and a half hours, (ii) the sample shall give a negative test for coliform bacilli in $\frac{1}{100}$ ml. of milk.

For Pasteurized Milk. Milk must not contain more than 100,000 bacteria per ml. at any time before delivery to the consumer. If tuberculin-tested milk is pasteurized and sold as 'Tuberculin-Tested (Pasteurized) Milk' it must not contain more than 30,000 bacteria per ml. before delivery to the consumer.

The difficulties of obtaining equipment to carry out the Holder method of pasteurization during the war led to the recognition in the Milk (Special Designations) Regulations for 1941 of the high-temperature-short-time method of pasteurization. The alternative method of pasteurization added by these regulations is laid as follows :—

Milk pasteurized by the high-temperature-short-time method shall be retained at a temperature of not less than 162° F. for at least fifteen seconds and be immediately cooled to a temperature of not more than 55° F. This method effects great economies in plant equipment and operating time over the older Holder process, but as the margin of safety to ensure the killing of tubercle bacilli is much less, local authorities are enjoined to exercise great care in approving the precision control apparatus laid down or suggested in the regulations to ensure that no milk which is not heated to 162° F. or held at that temperature for at least fifteen seconds enters the cooling section of the plant.

With the different war conditions, heat-treatment under less stringent regulations than either the Holder or the high-temperature short-time methods was recognized in the Heat Treated Milk (Prescribed Tests) Order, 1944, which, for the first time, recognized the value of the phosphatase test for determining the degree of heat-treatment to which the milk had been subjected. The test has been further recognized in the Milk (Special Designations) Regulations, S. R. & O. No. 10, 1946, which substitutes the phosphatase test for the plate count in assessing the efficiency of pasteurizing by the Holder or H.T.S.T. methods.

Tuberculin-Testing of Cattle

Various investigators are in agreement that about 40 per cent. of the dairy cows are infected with tuberculosis. The incidence of udder tuberculosis is less easy to assess. Available figures (Report 1931 (2) and Report 1932 (3)) suggest that the incidence among milch cows is between 0·02 and 2·0 per cent. The ideal policy to pursue is the detection and slaughter of infected animals before they infect healthy cows or secrete tubercle bacilli in their milk. The tuberculin test is a method which has been devised to detect infected cattle before they display any clinical symptoms under veterinary examination. Three methods of testing have been used (i) subcutaneous, (ii) ophthalmic and (iii) intradermal. The last is now the most commonly used. A first or sensitizing dose and a second or diagnostic dose are given after an interval of forty-two to seventy-two hours. The site of inoculation is generally the centre of the left side of the neck. An area of about 4 × 4 inches is shaved clean of hair and the injection is made in a fold of the skin which causes the formation of a small pea-like swelling. The thickness of the skin is always taken before the diagnostic dose and again twenty-four hours later. Non-infected animals show little increase in the thickness of the skin and the site of the injection remains hard and does not become inflamed. With infected animals, palpation of the site shows some œdema, the thickness being increased by 10 to 35 millimetres. Local heat and tenderness are generally also manifested. In tuberculin tested herds, reacting animals are disposed of, but the weakness of the present system lies in the fact that these reactors generally find their way into the ordinary commercial herds and therefore may infect animals which, while not having been tested, were free from tuberculous infection.

The Production of Clean Milk

Since 1920 the Ministry of Agriculture and the Department of Health for Scotland have conducted many clean milk campaigns, and numerous clean milk competitions, sponsored either by milk buying firms or county councils, have done much to educate milk producers in the essentials of clean milk production. During the second world war the necessity to utilize ever-increasing quantities of milk produced in Great Britain for the liquid milk market induced the Ministry of Agriculture to introduce a nation-wide National Milk Testing and Advisory Service. The milk of something like 90 per cent. of the producers is now regularly submitted to the resazurin-dye-reduction test at the point of first delivery, and farmers producing milk of poor keeping quality receive an advisory visit from an expert on the staff of the local War Agricultural Executive Committee or County Agricultural Education Committee. This has, at least, prevented further deterioration, and in areas not previously accustomed to sending milk to the liquid market, definitely improved production methods. The scheme is at present only advisory and many critics doubt whether a real improvement in standards of production will be obtained until milk is bought on a grade-quality basis, and the producer who continues to supply milk of poor keeping quality suffers a financial penalty.

The essentials to ensure the production of clean milk which will have a satisfactory keeping quality are (*a*) clean and sterile equipment, (*b*) clean cows, (*c*) clean milkers and dry handed or machine milking, (*d*) rapid and efficient cooling of the milk to a temperature not above 60° F.

To Ensure Clean and Sterile Equipment. The milking pails, if the milking is done by hand, or all parts of the milking machine which come into contact with the milk, strainers and churns, must be rinsed in cold water before the film of milk has had time to dry on the surface of the vessel or pipeline. This preliminary rinsing must be followed by vigorous scouring with hot water to which it is advisable to add a detergent to assist in removing the milk fat. After scouring, the equipment should be rinsed in clean hot water and then sterilized in a steam chest for twenty minutes after a suitably placed thermometer has recorded a temperature of 208° F. Numerous types of equipment for washing and sterilizing dairy utensils on the farm are available, but their cost deters many small milk producers from incurring the expense to make this essential twice-daily task easy. If the small producer is once convinced of the necessity of sterilizing his dairy utensils a reasonably satisfactory job can be done by boiling them in an ordinary copper, or a copper can be adapted to provide steaming facilities by fitting a suitable lid. Licences to produce tuberculin-tested and accredited milk are seldom granted by local authorities to producers who have not installed satisfactory sterilizing equipment.

The cow's udder, flanks and tail must be cleaned by washing immediately prior to milking. This task is made easier if the hairs on the udder and flanks are kept short by clipping and it is also a good plan to shorten the hair at the end of the tail. The fore milk, which may have a high bacterial count, should be drawn into a separate container and not added to the bulk. The milkers should be provided with clean overalls and caps kept solely for milking, have good facilities for washing their hands and be made to use them before milking commences and at any time during milking if they become soiled. If hand-milking is practised it is important to insist that it should be done dry handed.

Rapid and efficient cooling of the milk to a temperature not above 60° F. is on many farms most difficult to accomplish owing either to a shortage of water supply or the temperature to which rural water supplies often rise during summer. Lack of adequate supply of cooling water is, therefore, the most serious difficulty to be overcome before any great advance in the average keeping quality of the national milk supply can be secured. Mechanical refrigeration for the larger farms is a possibility, and the dairy engineers have already placed prototype machines on the market, which in time will be within the purchasing power of the larger milk producers. The operation of such machines is generally, however, dependent on electric power which is not universally available.

Pasteurization

The method of treating milk by heat followed by rapid cooling on the lines first discovered by Pasteur to prevent abnormal fermentation of wines and beers was gradually and of necessity adopted by the dairy industry in the larger towns in America and Europe, initially with the sole object of improving the keeping quality of the milk. Later it was found that this heat treatment to prolong the keeping quality could be so adjusted to ensure that any pathogenic organisms which might be present in the milk would be killed by the process. The destruction of micro-organisms depends on a time-temperature reaction, the longer the time, the lower the temperature required for destruction and *vice versa*. The following table is taken from Report 1937 (4) :—

TABLE 19

TIME TEMPERATURE EQUIVALENTS NECESSARY TO BRING ABOUT AN EQUAL DEGREE OF BACTERIAL DESTRUCTION IN MILK (Report 1937)

Temperature		Time
° C.	° F.	
60	140·0	63 minutes
62	143·6	25 minutes
63	145·4	16 minutes
64	147·2	10 minutes
65	149·0	6 minutes
66	150·8	4 minutes
70	158·0	38 seconds
72	161·6	15 seconds
74	165·2	6 seconds
76	168·8	2·4 seconds
80	176·0	0·4 seconds
85	185·0	0·04 seconds

Of the various disease-producing organisms which may be present in milk, the tubercle bacilli are the most difficult to kill. As a result of a vast number of experiments by different workers it is now generally agreed that tubercle bacilli are killed when subjected to any one of the following temperature-time combinations :—

138° F. for thirty minutes,
140° F. for twenty minutes.
145° F. for five to ten minutes.
150° F. for two to five minutes.
160° F. for twelve seconds.

It will be seen therefore that time-temperature range of 145° F. to 150° F. for thirty minutes in the Holder process and the 162° F. for fifteen seconds in the high-temperature short-time process leave a reasonable margin of safety to ensure that this most heat-resistant of the disease-producing organisms is killed by the process of pasteurization. In addition to destroying all the pathogenic bacteria, the process kills the majority of the non-pathogenic bacteria present and leaves the milk with a much reduced bacterial flora which will ultimately produce souring rather than putrefaction, and the onset of this souring is appreciably delayed. In other words, pasteurization increases the market life of the milk. It does not, however, make dirty milk clean and dirty raw milk not infrequently contains so many heat-resistant organisms which resist pasteurization that it soon becomes putrid. Pasteurization produces certain changes in milk. In the Holder process if the temperature goes appreciably above 145° F. the cream line subsequently thrown up in the cooled milk is reduced. It is important that following the heating and holding process cooling is efficiently and rapidly carried out, and the lower the temperature to which the milk is cooled the better the cream line. Above 145° F. the lactalbumin begins to be precipitated. The Holder process also causes a small proportion of the calcium and phosphates present in the milk to be precipitated in insoluble form. Of the vitamins in the milk A, B_2 and D are not affected, the reduction of B_1 is in the order of 10 per cent. and of C 20 per cent.

In the large commercial plants pasteurization, either by the Holder or high-temperature-short-time process, is usually performed before the milk is bottled or filled into cartons. In modern plants the heating takes place by passing the milk in thin layers between water heated plates or between water heated concentric pipes. The long holding period in the Holder process necessitates the provision of large holding tanks, to which the entry and exit of the milk is mechanically controlled to ensure that the minimum holding time is maintained. Devices for the fifteen seconds holding period in the high-temperature-short-time plants are much smaller, less complex, and are often combined with the heating and cooling unit. Cooling is done by passing the milk through a similar series of water and brine cooled plates or concentric pipes and in the first stage of cooling it is frequently arranged that the incoming cold milk is warmed by the outgoing hot milk. After the cooling is completed the milk is either bottled or filled into cartons. It is obvious that the same care and attention must be devoted to the sterilization of bottles as is advocated earlier for the cleaning and sterilization of dairy utensils. Bottle washing is now almost universally done by machine and great improvements in bottle-washing design have been effected in recent years, so that most plants now satisfactorily wash and sterilize the supply of returned milk bottles. This problem would, however, be greatly eased if all consumers could be educated to rinse and wash milk bottles before returning them to the dairymen.

A modification of the method of pasteurizing milk in bulk is pasteurizing in bottles, which has met with considerable success in plants of small and intermediate size. This method has obvious advantages in that contamination after pasteurization is eliminated, but the great disadvantage from which it suffers lies in the comparative slowness of heat transfer from the hot milk contained in the bottles to the cooling water after the holding process is completed.

In the Midlands and to a less extent in London and the North-West sterilized milk has become increasingly popular. This process consists of heating the milk in special narrow-necked bottles closed with Crown corks or swing stoppers to a temperature of 210° F. to 212° F. and maintaining this temperature for thirty-five to fifty minutes before cooling. Such milk has an appreciable cooked flavour, but it keeps sweet in the home for four to seven days and on this account appears particularly popular where there are no facilities for keeping foodstuffs cool. The cream in sterilized milk is emulsified by the process known as homogenization to prevent a separation of the fat globules during the prolonged temperature heating process. No cream line therefore forms on sterilized milk.

Condensed and Dried Milk

In addition to raw, pasteurized and sterilized milk, whole milk can be purchased in the form of unsweetened (evaporated) or sweetened condensed milk or as dried whole milk.

Machine skimmed unsweetened condensed milk is also on sale to the general public and, during the war, machine skimmed separated milk powder has been sold to the public under the label of 'National Household Milk Powder.'

In the condensing process, the water content of the milk is greatly reduced by boiling in large closed vessels maintained at a vacuum of 28 to 29 inches of mercury. At this pressure the liquid boils at temperatures between 102° and 130° F. For sweetened condensed milk, sugar is added to the heated whole milk either direct or in the form of a syrup before it is drawn into the condensing pan. No similar addition is made to the unsweetened condensed milk. When the correct degree of concentration has been achieved, the milk is run out and, in the case of unsweetened condensed milk, cooled to a temperature between 65° and 70°F. before filling into cans. Unsweetened condensed milk is homogenized to emulsify the fat after it leaves the condensing pan and is then filled into tins, sealed, and then subjected to a severe steam sterilization process. Unsweetened condensed milk is, therefore, a sterile product and its subsequent keeping quality depends on the efficiency of the sterilization process. Sweetened condensed milk is not sterilized and its keeping properties are dependent on the addition of the correct quantity of sugar, which reaches 40 to 45 per cent. in the finished product, to inhibit the subsequent growth of any micro-organisms in the milk.

The average composition of the three types of milk are given below :—

Table 20

	Unsweetend condensed milk	Sweetened condensed milk	Machine skimmed sweetened condensed milk
	Per cent.	Per cent.	Per cent.
Fat . .	9·1	9·1	0·5
Protein . .	8·6	8·4	10·1
Lactose . .	12·5	12·1	14·5
Sucrose . .	—	43·5	45·0
Mineral matter	1·8	1·8	2·2
Water . .	68·0	25·1	27·7

The domestic packs of unsweetened and sweetened condensed milks are covered by the Public Health Condensed Milk Regulations of 1923 and 1927, which lay down the minimum fat and solids content of the milks and prescribe a declaration which must be incorporated in the label on the tin. This declaration must state the pint equivalent of whole or skimmed milk in the tin. In the case of skimmed milk the declaration must also embody the words ‘ Unfit for Babies.’

Milk powder is prepared commercially by one of two methods (*a*) Roller drying, or (*b*) Spray drying. In roller drying the whole or skimmed milk to be dried is applied in a thin film to slowly rotating steel cylinders which are heated internally by steam under pressure. The film of liquid milk applied to the rollers dries rapidly and, on the opposite side of the roller to which the liquid is applied, the dry film is scraped off by means of a carefully adjusted knife set tangentially to the face of the roller. The powder leaving the rollers is passed through a brush sifter to remove burnt particles before packing into final containers.

Spray dried powder is manufactured by forcing milk under pressure through a fine jet into a large enclosed cylindrical tower, in which it meets a current of rapidly moving hot air. The droplets of milk issuing into the air stream are dried almost instantaneously and fall to the bottom of the chamber as a fine powder, which is removed either by mechanical means or special suction devices. The powder is sifted to remove any burnt particles before packing in containers.

In appearance, roller powder is darker in colour, larger in particle size and less soluble in water than spray powder. A good roller powder is 85 to 95 per cent. soluble in water, whilst a similar quality spray powder should not be less than 99 per cent. soluble. The difference in solubility is due to the high temperature to which the milk is subjected in the roller process which renders a certain fraction of the milk proteins insoluble. In the spray process, whilst the air temperature in the drying chamber is appreciably above the surface temperatures of the revolving roller used in the other method, the latent heat required to evaporate the moisture in the droplet and the speed at which evaporation takes place prevents any similar change taking place in the milk proteins.

The average compositions of dried milks are :—

TABLE 21

	Whole milk.	Skimmed milk
Fat	27·5	2·0
Protein	24·5	36·0
Lactose	38·0	49·5
Ash	6·0	8·0
Water	4·0	4·5

The packing of milk powders for retail sale is governed by the Public Health (Dried Milk) Regulations, 1923 and 1927. As for condensed milk, the label of each tin must contain a declaration specifying either full cream or machine skimmed dried milk, the liquid milk equivalent of the powder contained in the tin and, in the case of skimmed milk, the words ' Unfit for Babies.'

The Fortification of Milk

The vitamin D content of whole or evaporated milk mey be increased by irradiation with ultra-violet light, and all dried milks for infant feeding are now fortified by the addition of vitamin D before drying commences to ensure that they contain 280 international units per ounce.

State Schemes for the Provision of Milk to Children

During the recent war the Government introduced the National Milk Scheme whereby nursing mothers and all children up to the age of six years receive a priority allocation of 1 pint of milk per day, either free or at half-price, dependent upon the means of the parent. If so desired, the milk may be taken in dried form for children up to two years of age. In addition, there has been a great extension in the provision of milk to school children and about 90 per cent. of the children in attendance at elementary and secondary schools now receive one-third of a pint per day for payment of 1d. In the new social welfare scheme which will become operative during 1946, it is anticipated that school milk will be provided free of charge and as the supply position improves scholars may take up to two-thirds of a pint per day. This development is the outcome of pioneer experiments conducted by Corry (Man 1926), Orr (1928), Report (1938) on the ' Effects of Dietary Supplements of Milk on the Growth and Health of School Children.' During the war years, the National Milk and the Milk in Schools Schemes have absorbed an increasing percentage of the national milk supply and saturation point has not yet been reached.

The great importance of cows' milk in the human dietary lies in its high value as a protective foodstuff. Consumption, as a result of Government sponsored schemes, has increased by over 90 per cent. during the war years and the dietitians have set the target at not less than 100 per cent. increase over pre-war consumption. Much therefore remains to be done to improve the keeping and compositional quality of raw milk, effect further improvements in the efficiency of the pasteurization process and finally educate the public in the best use of milk in the home.

E. Capstick.

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APPENDIX I

BLOOD GROUPS AND RHESUS SERIES

The Classical Blood Groups. For purposes of blood transfusion it is sufficient to consider four groups, A, B, AB and O. Individuals of group A have anti-B in their serum, those of group B have anti-A, those of group O have both and those of group AB neither. For genetical purposes it is necessary to recognize two extra types A_2 and A_2B. The type A_2 may be regarded as a weak A. An even weaker type A_3 is known, but is too rare to warrant further consideration. In people of group A_2B the reactions with anti-A sera may easily be classified as negative unless special care is exercised.

Genetically the four antigens A_1, A_2, B and O are each determined by single genes forming what is known as a series of multiple alleles. This means that each ovum or spermatozoon carries only one allele, and that no individual can have more than two. Antigen O is recessive to all, whilst A_2 is recessive to A_1. Antigen B may be said to be partially dominant to A_2 since the reactions given by the latter are so much weakened in group A_2B.

TABLE I

The Genetic Constitution of the Blood Groups and their Frequency in London

Gene frequency of antigens $A_1 = 21{\cdot}2$. $A_2 = 5{\cdot}9$. $B = 5{\cdot}3$. $O = 68{\cdot}1$.

Group	Frequency	Genetic constitution
A_1	35·9	A_1A_1, A_1A_2 or A_1O
A_2	7·5	A_2A_2 or A_2O
B	8·4	BB or Bo
A_1B	1·2	A_1B
A_2B	0·6	A_2B
O	46·4	

TABLE II

The Progeny from Various Types of Mating

No.	Mating	Children possible	Children not possible
1	$A_1 \times A_1$	A_1, A_2, O	B, A_1B, A_2B
2	$A_1 \times A_2$	A_1, A_2, O	B, A_1B, A_2B
3	$A_1 \times B$	All	—
4	$A_1 \times A_1B$	A_1, B, A_1B, A_2B	A_2, O
5	$A_1 \times A_2B$	A_1, A_2, B, A_1B, A_2B	O
6	$A_1 \times O$	A_1, A_2.O	B, A_1B, A_2B
7	$A_2 \times A_2$	A_2, O	A_1, B, A_1B, A_2B
8	$A_2 \times B$	A_2, B, A_2B, O	A_1, A_1B
9	$A_2 \times A_1B$	A_1, B, A_2B	A_2, A_1B,O
10	$A_2 \times A_2B$	A_2, B, A_2B	A_1, A_1B,O
11	$A_2 \times O$	A_2, O	A_1, B, A_1B, A_2B
12	$B \times B$	B, O	A_1, A_2, A_1B, A_2B
13	$B \times A_1B$	A_1, B, A_1B	A_2, A_2B, O
14	$B \times A_2B$	A_2, B, A_2B	A_1, A_1B, O
15	$B \times O$	B, O	A_1, A_2, A_1B, A_2B
16	$A_1B \times A_1B$	A_1, B, A_1B	A_2, A_2B, O
17	$A_1B \times A_2B$	A_1, B, A_1B, A_2B	A_2, O
18	$A_1B \times O$	A_1, B	A_2, A_1B, A_2B, O
19	$A_2B \times A_2B$	A_2, B, A_2B	A_1, A_1B, O
20	$A_2B \times O$	A_2, B	A_1, A_1B, A_2B, O
21	$O \times O$	O	A_1, A_2, B, A_1B, A_2B

Reference to Table I will make it clear that people of group A_1 may have three different genotypes, those of groups A_2 and B two, whilst the remaining three have one only. Since A_1 and B show up in all combinations, it will be seen that they cannot occur in a child unless one parent has them. It should also be clear that people of the groups A_1B and A_2B can never have a child of group O, since one gene for O must come from each parent. In order to construct Table II it is only necessary to memorize the genotypes of each group ; the progeny of each type of mating may then be determined by ordinary algebraic multiplication. Thus with mating No. 6 ($A_1 \times O$), the group O person can only produce gametes with the recessive gene 'o,' whilst the other parent may be A_1A_1, in which case all the children will be group A_1 (genotype A_1o). If the genotype is A_1A_2, we have the multiplication $(A_1 + A_2)(o + o) = 2A_1o + 2A_2o$, that is to say, equal numbers of groups A_1 and A_2. Similarly $(A_1 + o)(o + o) = 2A_1o + 2oo$. These equations bring out an important point which applies to matings Nos. 1, 2, 3 and 6. Since persons of group A can be genetically A_1A_2 *or* A_1o, it follows that they cannot produce children of both groups A_2 and O. Suppose in a mating of type 6, an acknowledged child was group O and the legitimacy of a second child was questioned. Should it turn out to be of group A_2 or A_2B, it cannot have had the same parentage as the first child. Even if the first child belonged to the last two groups, we should exclude paternity if the father could be proved to come from a mating of $A_1 \times O$ since his genotype must be A_1o. It will be noticed that the best chance of excluding paternity occurs if the putative father is group O, and is best of all if the mother is also group O (Matings Nos. 6, 11, 15, 18, 20 and 21).

The Rhesus Series. In 1940 Landsteiner and Wiener found that if the blood of rhesus monkeys was injected into rabbits, a serum was obtained that would agglutinate the red cells of about 85 per cent. of people. Shortly after it was found that the sera of women whose children had hæmolytic diseases of the newborn (icterus gravis, erythroblastic anæmia, hydrops fœtalis) usually contained an agglutinin that would react with the red cells of the husband and of the affected child. Furthermore, both husband and the diseased child were rhesus positive, whilst the mother was rhesus negative. Genetical studies made it appear that one was dealing with a single gene pair Rh and rh, and that the mother, being rhrh, could form antibodies against the Rh antigens in her child. The husband might be RhRh, or Rhrh ; in the latter case half the children would be rhrh and therefore unharmed by the mother's antibodies. However, further studies with the sera of the type just described and from people who had become sensitized following blood transfusion, showed that there was more than one type of rhesus positive person, and finally that some sera reacted with the cells of rhesus negative people.

Obviously one is not dealing with a single gene pair, and one must next consider whether the situation is similar to that of the classical groups. Here it will be recalled that no person can have more than two antigens (say, A and B), and that no gamete can carry the gene for more than one. Fisher, Taylor, Race and their colleagues have found five distinct antibodies reacting with antigens of the rhesus family, and have deduced that a sixth should exist. The corresponding antigens have been labelled C, D, E, and c, d, e, and the missing antibody anti-d. They deduced that everybody had at least three antigens, and might have as many as six. In the former case they will have C or c, plus D or d, plus E or e, at least one member of each pair being present in every case. One might also find people who reacted with anti-C and anti-c, and similarly with the E pair. In this case the reactions with anti-c or anti-e were much weaker than when C or E were absent, and therefore the small letters were employed. The original rhesus factor is found to be antigen D. It is clear that the situation is more complex than with the A, B, O series.

Genetical studies have shown that C and c, D and d, E and e, are all determined by *different* gene pairs. Thus a person may be CC, Cc or cc, and similarly for the other pairs, except that whereas Cc or Ec people can be recognized by agglutination tests, we can only deduce the difference between DD and Dd by studying pedigrees. Without any further elaboration, we can deduce two rules for the determination of paternity. First, that a child can only have an antigen if at least one of his parents had it ; thus if two people are ee (which is quite common), the child cannot have E. Secondly, for a child to be homozygous (say, CC) both parents must have the antigen ; a mating by CC to cc will give Cc only. The serological recognition of heterozygotes is of importance for reasons other than paternity tests. If we have a mating of DD male by dd female, every child (being Dd) will stimulate the mother, and will be susceptible if antibodies are formed. On the other hand, if the father is Dd, only half the children will stimulate anti-D or be affected by it. Since D appears to be the most potent antigen, it is to be hoped that an anti-d will be found soon.

The above should not be difficult to understand ; the complications have arisen, partly owing to the confusion in terminology that has been inevitable during a period of rapid discovery, and partly owing to the genetical behaviour of these gene pairs. Now different gene pairs may be situated on different chromosomes or on the same chromosome. In any event, with three gene pairs there are eight possible gametes (see Table III). However, in the former case, if c, d and e came from one parent, and CDE from the other, all eight would be equally common ; in other words, there would be no tendency for the original combinations to stay together. In the latter case, the original combinations cde and CDE, will tend to be maintained, the great majority of gametes being of the two types named. Interchange of segments between pairs of chromosomes can be observed to occur during gamete formation, so that the combination is not absolutely stable. In the case of the rhesus series it can be shown that the combinations are remarkably stable, from which we deduce that the genes are very close to one another on the same chromosome.

TABLE III

The Rhesus Complex

Approximate gene frequencies C = 55. D = 61. E = 16.
(per cent.) c = 45. d = 39. e = 84.

Chromosome arrangements and frequencies :—

R_1(CDe) = 43·6. r(cde) = 37·9. R_2(cDE) = 12·8.
Ro(cDe) = 3·0. R''(cdE) = 1·7. R'(Cde) = 0·8. Rz(CDE) = 0·1.
Ry(CdE). Unknown.

Examples of some Chromosome Combinations

Name of Genotype	Chromosomes	Frequency	Number of antigens
(1). R_1R_1	$\frac{\text{CDe}}{\text{CDe}}$	19·0	3
(2). rr	$\frac{\text{cde}}{\text{cde}}$	15·0	3
(3). R_2R_2	$\frac{\text{cDE}}{\text{cDE}}$	1·5	3
(4). R_1R_2	$\frac{\text{CDe}}{\text{cDE}}$	10·5	5
(5). R_1Ro	$\frac{\text{CDe}}{\text{cDe}}$	3·0	4
(6). R_1r	$\frac{\text{CDe}}{\text{cde}}$	32·0	5
(7). R_1R''	$\frac{\text{CDe}}{\text{cdE}}$	1·5	6
(8). R_2r	$\frac{\text{cDE}}{\text{cde}}$	10·0	5
(9). Ror	$\frac{\text{cDe}}{\text{cde}}$	2·5	4
(10). R''r	$\frac{\text{cdE}}{\text{cde}}$	1·3	4
	Approximate total	96·3	

Actually, of the eight possible types of chromosome, only seven have been observed; each type is known by a symbol given in Table III. Only three of these are really common; these are CDe, cDE and cde. About 94 per cent. of all gametes carry one of these three—they are known as R_1, R_2 and r. Every person has two of these chromosomes, so that we may get people R_1R_1, R_2r, etc., giving twenty-eight types in all with the seven known chromosomes. It will be noticed from the table that all homozygotes (R_1R_1, etc.) have three antigens, whilst the heterozygotes have four, five or six.

Provided the principles are understood, there is nothing to be gained by trying to memorize all the possible combinations. These can easily be worked out on squared paper by writing the chromosome types on each side of a square, the diagonal giving the homozygotes, and the columns on one side of it all the heterozygotes. Owing to the extreme stability of the chromosomal arrangements, progenies can be worked out by the method given for the classical groups, *e.g.*, R_1r by $R_1R_2 = (R_1 + r)\ (R_1 + R_2) = R_1R_1 + R_1R_2 + R_1r + R_2r$. The complications that may arise through interchange of chromosome segments need not worry the reader since they are rare.

P. A. GORER.

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APPENDIX II

REPRESENTATIVE VOLUNTARY ORGANIZATIONS CONCERNED WITH CHILD WELFARE

It will be evident from a consideration of almost any aspect of child welfare work, that the children's services as they exist to-day have largely originated in the voluntary effort of individuals or societies who have recognized the need for particular reforms. Whilst some enlightened local authorities have been quick to adopt and develop such reforms, central legislation has in general followed only slowly, local authorities first being empowered to make grants to organizations started by voluntary effort and finally required to provide services which have been shown to be essential. There is still a great deal of children's welfare work which is only covered by voluntary organizations, and it will be obvious that the voluntary system (by which is meant the system in which social work is carried out by independent bodies rather than that the work is entirely unpaid) carries both advantages and attendant disadvantages. Thus whilst there is wide freedom in putting original ideas into practice, there is always a considerable danger of overlapping of effort and sometimes a risk of misuse of funds raised by private subscription. The first of these dangers has in many instances been met by the setting-up of co-ordinating committees for organizations working in the same field, whilst the Charity Organization Society and the Charity Commissioners hold a watching brief on the activities and financial trusteeship respectively of the various charities.

The historical background of the voluntary social services and their place in the modern State have been discussed in detail in a series of essays written under the auspices of the Nuffield College Social Reconstruction Survey (' Voluntary Social Services,' edited by A. F. C. Bourdillon, London, 1945); this authoritative study should be consulted not only for an account of the ' mingled callousness and humanitarianism ' which characterized the eighteenth century and the internecine squabbles between the various religious organizations which occurred in the nineteenth, but also for an assessment of the place of voluntary societies for child welfare at the present time. (There are, for instance, over 1,000 homes for children run by voluntary organizations, and as many children supported by them as are cared for by public assistance institutions). The following list of some of the more important organizations concerned with child welfare is not in any sense inclusive, but gives some indication of the extent and variety of social services covered. (Organizations concerned solely with sick or crippled children, or with adolescents, have been excluded.) For an inclusive list of charities in or available for the Metropolis, giving addresses and administrative particulars, ' The Annual Charities Register and Digest ' should be consulted (annually, Longmans, Green & Co. Ltd. and Charity Organization Society, London).

Advisory, Co-ordinating and Scientific Bodies

British Medical Association. Care of Children Committee.

British Pædiatric Association. Originally founded in 1928 with a limited membership as an association of children's physicians for the scientific study of disease in childhood, the Association has more recently extended its activities and now serves in an advisory capacity with regard to pædiatric training and appointments, and medical aspects of child health and welfare. In association with the British Medical Association, the B.P.A. controls the publication of the Archives of Disease in Childhood.

Child Health Planning Group is organized in area sub-groups, and membership is open to those interested in any branch of child health. Reports on various aspects of child health are published and discussions held.

Children's Nutrition Council (previously the *Children's Minimum Council*), founded in 1936, aims to ensure that 'no child shall by reason of the poverty of its parents be deprived of at least a minimum of food and other requirements necessary for full health.' Investigations are undertaken on causes of malnutrition in childhood, and proposals formulated for their improvement ; it has been described as 'a scientific body intruding into politics through the sheer impetus of the scientific facts that it represents.'

Family Welfare Association (previously *Charity Organization Society*) was founded 'to give a definite aim to, and to direct into the most effectual channels, the large amount of benevolent forces at work in England and particularly in London.' It now also raises and expends some £60,000 annually in relief of various kinds. An extremely valuable part of the work is the answering of inquiries with regard to particular charities, and the means available of obtaining assistance in individual cases.

Jewish Board of Guardians and Trustees for the Relief of the Jewish Poor serves as a co-ordinating committee and also directly administers relief. Apart from assistance given to necessitous families, the Board administers three convalescent homes for children, and has supported a residential nursery and a residential children's home and school. It also works in close co-operation with the Jewish Association for the Protection of Girls, Women and Children.

Royal College of Physicians : Pædiatric Committee was appointed in 1943 'to inquire into the education of undergraduates and postgraduates in the subject of Infant Hygiene and Diseases of Children ; and to make recommendations with regard to this branch of medical practice in the future.'

Royal Society of Medicine : Section of Pædiatrics holds regular clinical meetings or discussions on medical aspects of child health and disease in childhood.

Save the Children Fund was founded in 1919 by Eglantine Jebb, with the Charter quoted on p. 11. It is an international, non-political and non-sectarian effort to preserve child life. The Fund is founder-member of the Union Internationale de Secours aux Enfants (1920, Geneva), and a member of the Council of British Societies for Relief Abroad. Since its foundation it has undertaken a large variety of relief work for children, at home, in the British colonies and abroad. This has included the establishment of clinics, nursery schools, industrial training schools, model villages and a reformatory home. The Fund publishes a monthly journal, *The World's Children.*

Adoption Societies

National Adoption Society arranges the adoption of healthy infants (orphans, semi-orphans, and first illegitimates), and maintains a hostel for those awaiting adoption. Adoptions are arranged into families of the same religion.

National Children Adoption Association.

Some forty adoption societies have been registered under the Adoption of Children (Regulation) Act, 1939. These include the two abovementioned, and also the Crusade of Rescue (p. 347), National Children's Home and Orphanage (p. 345), and the Church of England Waifs and Strays Society (p. 345).

Children's Homes and Orphanages

The Council of Associated Children's Homes was formed in 1924, and has the following constituent bodies: Dr. Barnardo's Homes, The Catholic Child Welfare Council, The Church of England Waifs and Strays Society, The Jewish Board of Guardians, The National Children's Home and Orphanage, and The Shaftesbury Homes and *Arethusa* Training Ship. The associated council meets for consultation on all matters affecting the respective societies and children's welfare generally.

Dr. Barnardo's Homes were founded in 1866 by Dr. Barnardo, a 'Ragged School' teacher, and were for many years under his personal and dynamic direction. The work of Dr. Barnardo's Homes is primarily that of rescuing and maintaining destitute children. In various parts of the country there are Ever Open Doors at which children in need can be received at any hour. From these homes the children pass to a Centre where there is detailed physical and mental examination. Those thought likely to profit most from being brought up in a private household are boarded-out, whilst others are placed in residential homes or sent to special education homes or for treatment in one of the two Barnardo hospitals or in one of the Hospital Homes.

An outstanding feature of Barnardo's work is that any child other than an epileptic or mental defective is admitted, and physical condition is in no way a bar to admission. If the child is in need Barnardo's will help, and consequently the largest family in the world contains many for whom it is necessary to provide medical and surgical treatment for a considerable period. The Homes try to give to each child the teaching of the Church of England or of the Free Churches, according to the expressed religious views of the parent(s).

Every child is given a training in which he or she is able to become a self-supporting citizen; for this purpose there are maintained a technical school and two naval schools for boys, a domestic training school for girls, and Barnardo nursery homes in which girls train for the Certificate of the National Society of Children's Nurseries. There is efficient aftercare work for both boys and girls and a number of hostels for girls form part of this service. Emigration has long been a feature of the work and for this purpose homes are maintained at Toronto, Canada, and near Sydney, New South Wales.

There is also an extensive Auxiliary Boarding-out Scheme for the children of unmarried mothers. On an average seven or eight hundred children are always being assisted under this scheme.

Reference : Bready, W. (1930). 'Dr. Barnardo,' London.

The National Children's Home, founded in 1869, has thirty branches throughout the country in which it provides shelter and upbringing for 4,000 children. Its foundation principles are home life and family care in small groups with trained workers.

By the help of psychologists children are placed under conditions suited to their aptitudes, abilities and needs. Nursery, junior, senior and technical schools provide a progressive scheme for education. Training for careers is continued within the Home or subsidized outside the Home until boys and girls reach self-support. Higher education is by State and University scholarships. The National Children's Home has also its own scholarships fund, by which it awards scholarships and bursaries. It is possible, therefore, for any boys or girls with the right qualities of mind and spirit to find their way to any point of attainment however long and difficult the course may be, and to have placed in their hands all the opportunities which their natural ability and personal character qualify them to use.

Special physical needs are dealt with in an orthopædic branch for the care and cure of crippled children, and in a sanatorium for boys and girls received for treatment in the early stages of tuberculosis. A south-coast branch of the Home is especially concerned with the sunshine cure of young children and invalid boys and girls needing special care because of early malnutrition, rickets, post-rheumatic defects, and cardiac troubles.

Special attention is also given to the expert handling of the temperamental needs of maladjusted children, and in five of its centres the National Children's Home conducts approved schools under the Home Office for the reception of boys and girls from Juvenile Courts.

The Church of England Waifs' and Strays' Society, founded in 1881, has to date dealt with 58,000 children and has now in its care over 5,400, distributed in a hundred homes or with foster parents. From the beginning it has been a principle of the Society's work that the children should be housed in small units or, preferably, be boarded out in cottage homes ; the Society has been a pioneer in boarding-out, has practised it extensively and successfully, and has based its latest plans on an extension of the method. By this attention to the needs of the growing child, and the rule that children should not wear uniform or be debarred from the usual youth activities of their locality, the Society early made a commonsense approach to the psychological problems inherent in the task of caring for the 'institutional' child. There can be no doubt that these methods have been very successful.

On the health side the Society makes its contribution to child welfare chiefly by its positive attitude to the children's health : by assuring them of good food, good sleep, adequate recreation, and teaching them good habits. Each Home, whether for girls, boys, toddlers or babies, has a medical officer (a local doctor, who may be voluntary), who in many Homes, apart from care of cases of sickness, gives routine examinations and talks to the children. The Homes for children under five have a trained nurse as matron or sister. The school-age children of course come under the school health programme in the ordinary way.

The children in the care of the Society are essentially 'normal' children, and the care of the mentally defective is not undertaken. The Society has, however, two Homes for difficult children, and works in close conjunction with child guidance clinics and psychotherapists where the necessity arises. The Society has also from very early in its history been very much concerned with crippled children. Almost its first case was a crippled boy, and he was the forerunner of many. They were taken and treated in special Homes and the Society finally opened and maintained at Pyrford, Surrey, an up-to-date orthopædic hospital, where the children benefited from open-air treatment, occupational therapy, and remedial baths, and also schooling. Latterly the advances in orthopædics have been so great that the Society does not now make provision for permanent cripples, and the Pyrford Hospital, which contributed to the developments in orthopædic treatment, has recently been given up to adult patients, though there are always children under treatment and they have first call on the beds.

The present aim of the Society is to board out every suitable child of school age, after a probationary period in a receiving centre. Under a new scheme recently put in operation, the child is boarded out near the central receiving Home, which is also a club and supervisory centre; and physically and mentally the children have gained much from 'private life.' The Society has been successful in its use of foster-parents, and has always had supervision of the homes to which the children go, but the new method would seem to avoid the pitfalls of boarding out, and leaves the children with certain advantages they certainly enjoy as members of a group.

Foundling Hospital (now *The Thomas Coram Schools*), the oldest institution of its kind in Britain, was founded in 1739 by Royal Charter on the petition of Captain Coram. It was originally intended to admit any infant under two months old, other than those suffering from certain specified diseases, who was brought to the gate, without inquiry as to its parentage being made. When the available accommodation was filled, a notice was affixed outside, saying 'The House is Full.' It was soon found that the means at the disposal of the institution, which virtually undertook the adoption and rearing of the infants admitted, were quite inadequate to meet the demands; although admission had soon been limited by ballot, the institution by 1754 had some 600 children under its care and application was made to Parliament for financial aid. This was granted on the condition that all children offered under a certain age (at first two months and later one year) should be admitted. A number of country hospitals were established, and a basket hung at the door for the reception of unwanted babies. The system of general admission promptly led to abuses of all kinds; parish officers in many cases took advantage of this means of disposing of legitimate as well as illegitimate infants of paupers to avoid the cost of their upkeep, and a traffic sprang up in conveying infants from the country to the hospital. Within the hospital, the mortality of the infants reached appalling levels. In less than four years, the system of indiscriminate admission had to be abandoned. At this time (1760) there were over 6,000 children in the establishment.

After various modifications, the present rules of admission were established. These provide that infants admitted must be under twelve months of age and the children of unmarried mothers; that personal application must be made by the mother; that a true state of the mother's case must be given; that the committee must be satisfied as to the previous good character and present necessity of the mother, that the father has deserted her, and that the admission of the child 'will in all probability be the means of replacing the mother in the course of virtue and the way of an honest livelihood.' No money is received for the admission of children. On reception, the infants are placed in foster-homes under medical supervision until the age of about five years, when they return to the hospital. Within the institution the children receive elementary education; at the age of fifteen or sixteen they are found employment or in some cases receive higher education or special training. The hospital keeps in touch with the children until they come of age. In addition to maintaining over 600 children, the institution had before the war been responsible for a day nursery, a nursery school, a holiday play centre, a home for young women before confinement and after confinement with their babies, and other child welfare activities.

Reference: Nichols, R. H. and Wray, F. A. (1935), 'The History of the Foundling Hospital,' Oxford University Press.

The Children's Aid Society, established in 1856, and for many years under the presidency of Lord Shaftesbury, has as its main object, 'the rescue and care of children likely to be in want or moral danger.' Before the war the Society maintained a home for nursing mothers and their babies (run in connection with an affiliated maternity home), and six children's homes. It is also the controlling organization of the Anchorage Mission, for the assistance of the unmarried mother and her child. The Society has aided well over 100,000 children since its foundation.

The Salvation Army maintains three homes in London and thirteen in the provinces for unmarried mothers and their infants. The mothers are admitted a month before their confinement, and remain for three to four months afterwards until provision can be made for them. From the London homes, the mothers go to the Mothers' Hospital in Clapton for the birth of the child, this hospital being a recognized midwifery training school. In addition, the Salvation Army has three homes for the under-privileged child; the children remain until the age of sixteen, and are allowed to choose the work that they would like. Special educational facilities are arranged for those having the necessary qualifications.

Shaftesbury Homes and 'Arethusa' Training Ship were founded in 1843 to provide a home and industrial training for homeless and fatherless children. In addition to the 'Arethusa' training ship, four homes or schools for boys and one home for girls are maintained. The work originally grew from that of the Ragged School Union, which was also the parent of the Shaftesbury Society.

Incorporated Society of the Crusade of Rescue and Homes for Destitute Catholic Children, founded in 1859 for the rescue of children in the Dioceses of Westminster and Brentwood and elsewhere, maintains a boys' home at Enfield, a home for girls, toddlers and babies at Feltham, and a home for mothers and babies at Highbury Hill.

The Caldecott Community was founded in 1911 as a nursery school in St. Pancras, and in 1917 moved to Kent, becoming a country boarding school for London working class children. In 1930 it was decided to make the Community a home for the insecure child. At the present time 60 per cent. of places are allocated to children from homes where severe parental friction is known to exist, children from homes broken by death, crime, divorce or separation, illegitimate children, and children recommended by child guidance clinics. The remaining 40 per cent. are allocated to children sent by local education authorities, either unstable children showing behaviour difficulties (20 per cent.) or children under eleven who have been charged under the Children and Young Persons Act (20 per cent.). The community of a hundred children is grouped into five interdependent companies, based partly on chronological age and partly on mental, emotional, and social development. The children receive medical and psychiatric supervision, and standard intelligence testing is employed. The Community is in practice a social experiment in rehabilitation of the insecure child, in which sympathetic study of the individual serves as the first step in encouraging social development. The outstanding success of the experiment is reflected in the support it receives from local education authorities and others.

Child Guidance and Mental Health

The Provisional National Council for Mental Health seeks to promote an understanding of the principles underlying healthy mental and emotional development in children and to emphasize the need for such understanding in connection with the maintenance of mental health and the prevention of mental disorder in later life.

In pursuit of this end, it organizes courses and lectures for medical officers, nurses, teachers, health visitors, probation officers and other social workers, staffs of children's homes and hostels, etc., as well as for parents and for the general public.

Advice is given on individual cases of mentally defective, educationally subnormal, maladjusted and epileptic children in need of schools, homes or foster-homes, or of child guidance treatment, and the Council is itself responsible for several homes for children who are mentally defective, for a residental nursery for difficult 'under-fives,' and for a hostel for maladjusted children (boys) in need of prolonged treatment at a child guidance clinic.

The Council is concerned with the welfare of homeless children in its mental health aspects, and is carrying out an investigation by means of a grant from the Nuffield Trust, into the social adaptation of children and young persons brought up in institutions.

It is also concerned with the promotion and establishment of child guidance services, and awards Fellowships for training at selected child guidance clinics, in child psychiatry and in educational psychology. The Council has a staff of educational psychologists whose services are available on loan to education authorities for the purpose of making surveys into the incidence of backwardness and maladjustment amongst school children and for suggesting methods by which the necessary educational and clinical provision can be instituted. They can also be loaned to authorities responsible for maternity and child welfare centres, for the purpose of giving advice to mothers of young children on psychological problems connected with their upbringing, and to voluntary organizations with homes for handicapped children of various types.

The Council has a library (with postal service) from which books can be borrowed on child psychology, child psychiatry, psychology education, etc.

Reference (Child Guidance Clinics): British Pædiatric Association, 'Report of Child Psychology Sub-Committee.' (1946), *Arch. Dis. Childh*, 21, 57.

Convalescence, Country Holidays, etc.

Children's Country Holiday Fund (*Inc.*), was founded in 1884, with the purpose of providing country holidays for poor children who would not otherwise get them. About a thousand voluntary helpers in London serve to choose the children, collect contributions, see the children off, and meet them on their return. Another thousand workers throughout the country meet the children, distribute them to their hostesses, and supervize their welfare during their two weeks' holiday. (During the war it was necessary to restrict holidays to those specially recommended by doctors, almoners, the Invalid Children's Aid Association, Charity Organization Society, or other responsible body.) During the sixty years of its work (up to 1944) the Fund has been responsible for providing country holidays for well over 1,500,000 children. The organization is undenominational.

Invalid Children's Aid Association. The Invalid Children's Aid Association (founded in 1888) tries, by undertaking the after care of children discharged from hospital, to fill the gap between hospital and home. It is an agency for children's social service ready to furnish reports on home conditions and to provide convalescent treatment, both long and short term, and surgical appliances on the recommendation of the physician or surgeon transmitted now by the hospital almoner.

Throughout its history the I.C.A.A. has co-operated with public health authorities and education committees. Six of its own homes are approved by the Ministry of Education as residential open air schools and many educational committees use beds for children under five in the Association's homes. The Association also reserves beds in homes on its approved list and the policy is not just to find a place, but, guided by its long experience, to find the most suitable place for the particular child according to physical condition, family history and home background.

The Association covers the whole of the Greater London area and has federated societies in the provinces doing similar work. (A list can be supplied on application.) The London I.C.A.A. is prepared to help any case in an area where there is no similar society. Although the Association is administered centrally its structure of Branch Committees keeps alive a spirit of local self-help and preserves a human touch essential for work of this kind. Medical students interested in social work for their child patients may attend the Case Committees of the Association.

District Nursing

The Queen's Institute of District Nursing is a voluntary organization founded in 1887 by Queen Victoria. The large majority of the County and District Nursing Associations in Great Britain are affiliated to the Institute, and 98 per cent. of the country is covered by a District Nursing Association. The Institute is responsible for providing special district nursing training to State Registered Nurses to enable them to become Queen's nurses. The Institute also inspects the service regularly to maintain a high standard of nursing care for patients who are nursed in their own homes. Much of the work of Queen's nurses is with children. In the country areas Queen's nurses also undertake midwifery and in a great many counties combine this with health visiting and school nursing work. The nature of their work brings them into close contact with the family and their influence in health teaching and social care is considerable. The encouragement of breast-feeding, the early detection of deviations from the normal, and the reference of children requiring medical attention to the family doctor or clinic, with subsequent follow-up visits to see that the treatment recommended has been obtained, form an important part of their work.

A district nurse works only under the direction of a doctor, usually the family doctor, who refers the case directly to her (or, if there is a group of nurses living together, to the superintendent). The address of each is in the telephone book. Children in need of nursing or advice are also referred from hospitals or Public Health Departments. Payment for nursing visits is made by family at a fixed cost per visit, or according to means, or more frequently through a local voluntary contributory scheme, whereby a penny or twopence per week entitles the whole family to free nursing at home as long as required. The necessitous are always nursed free of charge.

Home Nursing Scheme (the Greater London Provident Scheme for District Nursing) works in association with The Queen's Institute, The Ranyard Nurses, etc., and is an example of the contributory scheme referred to above.

Central Council for District Nursing in London, founded in 1914, serves to co-ordinate district nursing in the London area.

Emigration

Dr. Barnardo's Homes (see p. 344).

Fairbridge Farm Schools. The first committee of the Child Emigration Society was formed on the initiative of Kingsley Fairbridge when a Rhodes Scholar at Oxford, and in 1913 the first group of boy settlers were received by him in Western Australia. The farm school was kept in existence throughout the first World War, and in 1919 the founder was able to revisit England and rekindle interest in the venture ; on his return he acquired 3,000 acres in Western Australia, where the present farm school is situated. By 1923 the scheme had shown such promise that it received financial aid from the British and Western Australian Governments. In 1934 the London Committee of the Child Emigration Society decided to open additional farm schools in the Dominions, and a further school was opened in 1935 in Vancouver Island ; the first party of children to reach Vancouver were for the most part from Tyneside. A third farm was subsequently acquired in New South Wales, and a school built for the purpose by the Government of New South Wales. Close collaboration between the Fairbridge Farm Schools and the Northcote Farm School in the State of Victoria was established in 1937. Owing to the dangers of transport during the recent war, no children were sent overseas after 1941, and suitable candidates were maintained in the Society's care in the Fairbridge Hostel in England. Emigration was restarted in September, 1945.

Necessitous children up to twelve or thirteen years of age, who are considered physically and otherwise suitable, are selected in this country and after being medically examined by the referee of the Canadian Government, are placed in the care of the Society for a period of probation and preparation. Up to October, 1945, 1,749 children had left this country for the Fairbridge Farm Schools in Australia and Canada.

Health Education

Central Council for Health Education, recognized by the Minister of Health as ' the one agency for education in matters of health education generally ' in England and Wales and ' the private body to advise him on the dissemination of information conducive to the health of the people' works closely with the Ministry of Education, local education and public health authorities, medical and educational professional bodies and all concerned with health education.

The Council regards the promotion of child health as an important part of its work and is glad to co-operate with all individuals and bodies working to this end. It can give help in the following ways :—

(1) By giving advice on the content and methods of health education programmes and organizational help in carrying them out (free).

(2) By providing courses of lectures to doctors, nurses, health visitors, teachers, parents, schoolchildren, etc. (two guineas per lecture plus travelling and maintenance expenses).

(3) By supplying pamphlets and posters (at cost price). These deal with the common diseases of childhood, the nutrition of the expectant mother and the toddler, the pasteurization of milk, insect parasites, sex education, and the problems of child rearing.

(4) By the loan of 16 mm. sound films (free, borrower paying postage). Films are available dealing with droplet infection, the head louse, breast feeding, posture, healthy habits, sex and reproduction, care of the feet, and care of the eyes ; while films in preparation deal with the care of children's teeth, ears, nutrition, sleep, parentcraft, and sex education in the home.

The Marriage Guidance Council aims at promoting sound marriage, which is the foundation of sound family life. In this way it contributes to child health by seeking to promote a harmonious relationship between parents.

First started in 1938, the Council was reconstituted in 1943, under the joint Presidency of Lord Horder and the Bishop of London. Membership is open to subscribers who approve of the aims and principles set out in its Memorandum. The work of the Council is both preventive and remedial. It seeks to foster education for marriage and family life in every way possible—by means of personal instruction and sound literature, and through lectures and other means of group teaching. It believes that the key to happy marriage is thorough preparation for it.

At the same time, help is offered to those in marriage difficulties through the establishment of Marriage Guidance Centres. These are staffed by means of consultants giving voluntary part-time service, and equipped to offer medical, psychological, legal and spiritual guidance. The aim is to advise in simple difficulties, and direct those needing specific treatment to the proper quarter.

Maternity and Child Welfare

National Council for Maternity and Child Welfare (*Incorporated*). The main objects for which the Council is established are: to promote interest in and to forward the development of the welfare of mothers and children; to provide a central bureau of information on subjects connected with maternal and child welfare and to maintain a library on such subjects which would be available to students and other workers concerned; to organize popular instruction by means of exhibitions, museums, lectures, demonstrations, loan of teaching appliances or otherwise; to hold or organize conferences and congresses of authorities and organizations concerned with maternal and child welfare.

The Council has nineteen constituent societies and they can be grouped under the following headings: maternity work; care of the child at home; nurseries; handicapped children; fatherless children; child guidance; eugenics.

The work of the Council co-ordinates the services of the constituent societies and forms a liaison between Government departments and voluntary societies engaged in child welfare work. Meetings and conferences are arranged and group committees are set up to take evidence, inquire into and report on questions of particular importance. The Council provides a bureau of information and library. A small circulating library has long been in existence. Books are in particular demand by matrons and nurses in nurseries. A reference library has recently been initiated and some of the standard books of reference provided.

A bureau of information was opened in 1943. Information is collected and classified so that it is readily available. The reports of all Medical Officers of Health of the country are collected as well as the reports of the chief voluntary associations concerned with maternity and child welfare. Government circulars, pamphlets and press cuttings are filed and indexed for reference. A classified statement of these is issued every two months.

To promote the work of the bureau of information a monthly survey is now circulated. The survey draws together information about the welfare of mothers and children from Hansard, the daily and weekly Press and the publications of health and educational bodies. It is strictly factual. The Council has a permanent exhibition at Carnegie House. This can be visited by the general public. It is used for teaching, parties of students being instructed by the organizer.

The travelling exhibitions consist of exhibits, models, photographs, films, posters and pamphlets which are sent all over the country for teaching purposes. The travelling exhibitions are used by local welfare authorities, British Red Cross Society detachments, units of the Women's Services and other organisations. Good designs for children's clothes are obtained and patterns are cut and sold. A clothing coupon concession is allowed by the Board of Trade to nursery nurses in nurseries controlled by voluntary committees on charitable institutions and the Board, although defraying the cost, has delegated the work involved to the Council.

National Association of Maternity and Child Welfare Centres and for the Prevention of Infant Mortality (1911). See Chapter XIV, p. 251.

Moral Welfare

(It will be obvious that many of the religious and other organizations and particularly youth organizations, described elsewhere, are largely concerned with the moral welfare of children. Several of the following organizations have been concerned amongst other activities with the legislative aspects of moral welfare of children, *e.g.*, delinquency, prostitution, illegitimacy, and adoption).

The Association for Moral and Social Hygiene was founded in 1870 to oppose all forms of official regulation and commercial exploitation of vice, and to study and promote such legislative, administrative, social, educational and hygienic reforms as will tend to encourage the highest public and private morality. A memorandum for magistrates on sexual offences against young persons and other publications dealing with the treatment of persistent sexual offenders against children have been issued.

Association of Children's Workers for Moral Welfare.

British Social Hygiene Council.

Federation of Committees for the Moral Welfare of Children.

Jewish Association for the Protection of Girls, Women, and Children.

Howard League for Penal Reform was founded in 1866 for the prevention of crime and juvenile delinquency.

National Council for the Unmarried Mother and her Child, founded in 1918, has worked for legislative reform, particularly with regard to the Bastardy and Affiliation Acts ; encouraged local authorities to make full use of their powers for the care of mothers and children ; encouraged the provision of accommodation for unmarried mothers and their children throughout the country ; and provided a case department for dealing with individual inquiries. The Council has also published a useful memorandum for the guidance of social workers on points of law relating to unmarried mothers and illegitimate children.

Shaftesbury Society, founded as Ragged School Union in 1844, to ' promote the religious education of the poorest and most destitute children ' in the principles of the Protestant Evangelical Churches of England. The strong religious impetus of the Society has been maintained for over a hundred years. The Society supports a large number of missions, mainly in the Metropolitan area, four residential schools for cripples, over a hundred ' parlours ' and clubs for cripples in Greater London, ten holiday homes, camps or fresh-air centres, and a ' Barefoot Department ' which normally distributes over 50,000 garments and 3,000 pairs of shoes annually.

Nurseries and Nursery Training Colleges

National Association of Children's Nurseries (see Chapter XVI).

Association of Nursery Training Colleges, founded in 1925, exists 'to encourage a high standard of training in Nursery Colleges, and to promote the welfare of the Nursery Nurse.' The affiliated colleges include All Saints' Nursery Training College, Harrogate ; The Edinburgh School of Mothercraft ; The Dolphin Nursery Training School, London ; Hoylake Babies' Hospital and Nursery Training College ; The Mothercraft Training Society, Cromwell House, Highgate ; The Norland Institute and Nurseries Ltd., London ; The Princess Christian Infants' Nursery and Nursery Training College, Windsor ; St. Christopher's Nursery Training College, Tunbridge Wells ; St. Gregory's Babies' Home and Nursery Training College, Plymouth ; and Caversham Babies' Home, Reading.

Nursery Schools

The Nursery School Association of Great Britain (see Chapter XVI). The aim of the Association is to enlighten public opinion on the subject of nursery schools, and to encourage local authorities to establish them. The Association publishes a number of leaflets dealing with the Nursery School movement, and the planning, equipment and staffing of nursery schools, and supplies information on request.

National Froebel Foundation.

The Montessori Society Schools.

The majority of nursery schools are now State-aided or State-controlled, though many, *e.g.*, The Rachel MacMillan School, have been initiated by private effort.

Training Colleges. The following training colleges are recognized by the Ministry of Education, and offer a two-year or three-year training and prepare for the Teachers' Certificate : The Diocesan Training College, Bristol ; Southlands Training College, Wimbledon ; Avery Hill Training College, Huddersfield ; Darlington Training College ; Diocesan Training College, Thulston ; Froebel Educational Institute, London ; Gipsy Hill Training College, Bingley, Yorks ; Homerton College, Cambridge ; Maria Grey Training College, Dudley, and Rachel McMillan Training College, Deptford.

Playgrounds and Play Centres

Children's Play Centres Fund was founded in 1897 for the provision and running of play-centres for children of school age (five to fourteen years). The fund became grant-aided in 1917, and in 1941, with the increased need for play-centres for the care of children engaged on war work, the work was taken over by the London County Council. A 100 per cent. grant was made to centres opened specially to meet this need. In September, 1944, there were 108 play centres of various kinds opened in London. War-time play centres were normally opened at the end of afternoon school and closed at 7 p.m. Tea could be provided for children at a charge of 2d. In some instances an excellent breakfast could be provided before school at a charge of 3½*d.*, the meals being provided by the Londoners' Meals Service (the London equivalent of British Restaurants). Fifteen other evening centres not scheduled as 'war-time play centres' have been opened in schools. During the school summer holidays in 1945, sixty-four holiday centres were opened for varying hours, and fourteen organized games evening centres in the parks during the summer months.

Occupation in the Play Centres is as far as possible out of doors, but indoor activities for the winter months and in wet weather includes painting, dramatics, games, basket work, weaving, choir singing and percussion bands, boxing, metal work, signalling, and 'keep-fit' classes; first aid, woodwork, dressmaking, mothercraft, and country-dancing classes have proved very popular in some centres. Wherever centres are close together, inter-centre matches are encouraged.

The average attendance at the centres in the winter of 1944–45 was 100 per evening per centre; the pre-war average was 280 per evening per centre when fifty centres were open. (With the return of children from evacuation the attendance is likely to increase considerably).

The National Playing Fields Association was formed in 1925 following preliminary investigations which had disclosed that four million children in this country had no safe place in which to play; whilst secondary schools were well equipped with playing fields, it was the exception rather than the rule to find similar provisions made for children in the elementary schools. The Association, whilst putting in the foreground the provision of safe playing grounds for children, has also given prominence throughout to the needs of persons of all ages. Of late years, however, a special urgency has been imported into the work for children by the terrifying statistics of mortality on the roads, resulting in the necessity for getting either the motors or the children off the roads. The Association has always advocated the latter course and worked to that end. It has happily been instrumental, in co-operation with Central and Local Authorities and with National and Local Voluntary Organizations, in providing and equipping 584 children's corners in England; 5 in Northern Ireland; 110 in Scotland; and 58 in Wales. During the war, the work of the Association had to be drastically curtailed; some 250 grants promised for playing fields under the National Fitness Fund were withdrawn and 200 others reduced. The Association has, however, put forward a report for Government consideration on the provision of playing fields in post-war planning, in which the urgent necessity of reserving sites for children's playgrounds in the replanning of bombed areas is emphasized. It is pointed out that in crowded residential areas no child should have to walk more than a quarter of a mile to find a playground. The Association has received liberal financial support not only directly from the public but also from the Carnegie Trust, and the King George's Fields Foundation (the national memorial to King George V), and has obtained the approval of grants of over £500,000 by the National Fitness Council. In the course of sixteen years work, the Association and its Branches have been largely responsible for acquisition by local authorities or committees of approximately 2,500 new playing fields and playing grounds.

Preventive Medicine

National Association for the Prevention of Tuberculosis is concerned with research, education, and propaganda in the widest sense, and these activities during the past forty-five years have initiated many of the features which are accepted as part of our national tuberculosis measures to-day. A number of socio-medical inquiries have been carried out (in Tyneside, Cyprus, West Indies, Burma), and an investigation into the psychology of tuberculosis has been started. Educational activities include the planning of refresher courses for doctors, health visitors, and other tuberculosis workers. Child health and the protection of the child from the tubercle bacillus, the early recognition of child tuberculosis, and prompt measures to stop infection are a feature of these courses. Propaganda work is carried out largely among children, to whom cinema films and lecture demonstrations are given upon health ideas and the promotion of bodily and mental resistance. The N.A.P.T. is a voluntary body and draws no funds from the Government.

The People's League of Health (*Inc.*), founded in 1917, has undertaken propaganda and socio-medical investigations, some of which relate more or less directly to child health (*e.g.*, Interim Report on 'Nutrition of Expectant and Nursing Mothers' (1942), *Lancet*, *ii*, 10).

Prevention of Cruelty to Children

National Society for the Prevention of Cruelty to Children. Each year this Society helps no less than 100,000 of the nation's children. Not all of these children have been ill-treated, and in fact the number physically ill-used is comparatively small. In the majority of the cases that the Society deals with, the children have been neglected. Neglect takes many forms, but generally it means that in so far as the Society is concerned the children have been kept in filthy and verminous homes. It can fairly be said that were it not for the work the Society has done during the past sixty years the standards of cleanliness in many of the towns and villages would be much lower than it is.

The Society works in close co-operation with the health departments of local authorities, and in many areas where parents neglect to obtain some needed medical or surgical treatment for their children the Society is called in to see what it can do. Always the inspectors try to persuade the parents to obtain the necessary treatment, but where efforts at persuasion fail, the Society in the interests of the children sometimes institutes a prosecution.

The Society if it can possibly do so avoids taking action in the police court and last year in only 3 per cent. of its cases was a prosecution instituted. To bring about the result desired, however, often means that a case has to be visited many times in order to ensure that there shall be no slipping back into old ways, and that the conditions for the children shall be permanently improved. Last year the number of visits of various kinds paid by the inspectors was considerably over 400,000.

The Society has in many parts of the country earned a reputation amongst parents for being an almost specialist body to give advice in regard to child problems. Last year, one in six of its cases concerned children whose parents had sought on their behalf the Society's advice and help.

Without a great deal of voluntary help the Society could not carry on, and it relies for the greater part of its income on contributions raised by honorary collectors who number over 30,000. These workers, in addition to obtaining funds also distribute literature regarding the Society's activities and this brings to light many cases that would not otherwise come under notice.

The actual work of dealing with the cases is undertaken by the inspectors, a paid body of men and women who are carefully trained for their work. There are at the moment about 270 of them and it is hoped that in the not too distant future that it will be possible to increase their number to 300. Many of the new inspectors will be women, whose especial task will be to help children who are needing medical attention.

The Society is governed by a nationally elected council which meets annually, and which in turn, elects an executive committee composed of honorary workers of all shades of political and religious opinion. This committee meets frequently, and it is this body which really directs the Society's activities, although it is, of course, answerable to the National Council.

There is also a Scottish Society affiliated to the National Society, and having the same aims and activities.

Youth Organizations

The Standing Conference of National Voluntary Youth Organizations (in association with the National Council of Social Service) is a consultative body, the purpose of which is 'to consider matters of interest to the constituent organizations and means whereby their work may be extended and strengthened and make representations to statutory bodies or to other appropriate quarters.' The eighteen constituent organizations include the Boys' Brigade, The Boy Scouts' Association, The Church Lads' Brigade, The Girl Guides' Association, British Red Cross Society, St. John's Ambulance Brigade Cadets, Salvation Army (Youth Department), Co-operative Youth Movement, Girls' Guildry, Girls' Life Brigade, National Association of Boys' Clubs, National Association of Girls' Clubs and Mixed Clubs, and the Welsh League of Youth. Close contact is maintained with the Association for Jewish Youth, the Youth Department of the British Council of Churches, The National Catholic Youth Association, The Air Training Corps, The Sea Cadet Corps, and The British Cadet Association. The conference has published a number of pamphlets dealing with youth organizations.

The Boys' Brigade, founded in 1883, for boys aged twelve to eighteen, had in 1944 a total membership in the United Kingdom of over 94,000 ; the junior branch (The Little Boys, for boys aged nine to twelve) had a further membership of 42,868. The primary object of the Brigade is religious and character training, a wide variety of recreational and other activities being included in the programme.

The Boy Scouts Association, founded in 1908 by the late Lord Baden-Powell, had in 1939 a world membership of 3,500,000. The membership in the United Kingdom in 1944 was 452,764. The age limits for a boy scout are twelve to eighteen, there being in addition a junior branch (Wolf Cubs) for boys aged eight to twelve. The aims of the Association are 'to develop good citizenship among boys by forming their character, training them in habits of observation, obedience, and self-reliance, loyalty and thoughtfulness for others, teaching them services useful to the public and handicrafts useful to themselves; promoting their physical, mental and spiritual development.'

The Church Lads' Brigade, founded in 1891, for boys aged eight to twenty-one, had in 1944 an approximate membership of 25,000. It has been described as 'The Church's Missionary Society to Adolescent Lads.' Apart from religious instruction and recreational and social activities, considerable emphasis is placed on drill and discipline.

St. John Ambulance Brigade Cadets consists of the Ambulance Cadet Divisions for boys and the Nursing Cadet Divisions for girls; the age of entry is from eleven to seventeen years. Training is given in first aid in the case of boys and first aid and home nursing in the case of girls, and proficiency certificates awarded in a variety of other associated activities, *e.g.*, life-saving, hygiene, cookery, child welfare, handyman.

The Welsh League of Youth (Urdd Gobaith Cymru) was founded in 1922 'to develop Christian citizenship amongst the youth of Wales.' In addition to the usual club and camping activities, typically Welsh activities are fostered.

The Co-operative Youth Movement consists of clubs, which are largely self-governing, under a leader appointed by the local Co-operative Education Committee, and exist to develop character and to 'teach the social significance of co-operation as a way of living.' Members are divided into Rainbow Playways (aged seven to eleven), Pathfinders (eleven to fifteen), Youth Clubs (school leaving age to twenty).

The Girls' Guildry, founded in 1900, aims to train girls to become 'good Christians and responsible citizens'; attendance at some form of religious instruction is obligatory. There were in 1944 between 30,000 and 35,000 members, divided into The Guildry Garden (under nine), The Guildry Greenwood (nine to twelve years), The Guildry Company (twelve to sixteen years), and The Guildry Service Group (over sixteen years).

The Girl Guides' Association was founded with similar ideals to those of The Boy Scouts' Association, and in 1944 had a world membership of 1,398,553 (of which 485,063 belonged to Great Britain and Ulster). Members are divided into Brownies (aged seven to ten years); Guides (aged ten to fourteen or fifteen); and Rangers (fourteen to twenty years), whilst other branches exist for particular categories.

Girls' Friendly Society, was founded in 1875 to promote the social welfare of women and girls. Officials must be members of the Church of England, but membership is not limited to this denomination. The age of entry is seven years. The Society had (in 1944) 19,436 members aged seven to thirteen, and approximately 35,000 members over thirteen.

The Girls' Life Brigade, founded in 1902, is interdenominational and non-political, with a recent membership of approximately 54,000. The aim is 'to help and encourage girls to become responsible, self-reliant and useful Christian women.' The age entry is nine to twenty years, but a younger section caters for children aged six to nine years. Companies are attached to Churches (Established or Free).

(*The National Association of Boys' Clubs* and *The National Association of Girls' Clubs and Mixed Clubs* are concerned primarily with children of 14 +, though in some instances affiliated clubs may make provision for younger children).

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